

# CHEMICAL & METALLURGICAL ENGINEERING

New York, October 15, 1918

McGraw-Hill Company, Inc.

Vol. XIX, No. 8 25c a copy

**CLEAN PRODUCER GAS PLANTS  
COAL GAS PLANTS**

Electrical Precipitation

Welded Steel Pipe

Gate Valves

Concrete Oil Storage Tanks

Concrete Purifier Boxes

**GAS ENGINEERS AND BUILDERS**

**Steere Engineering Company**  
Detroit, Michigan

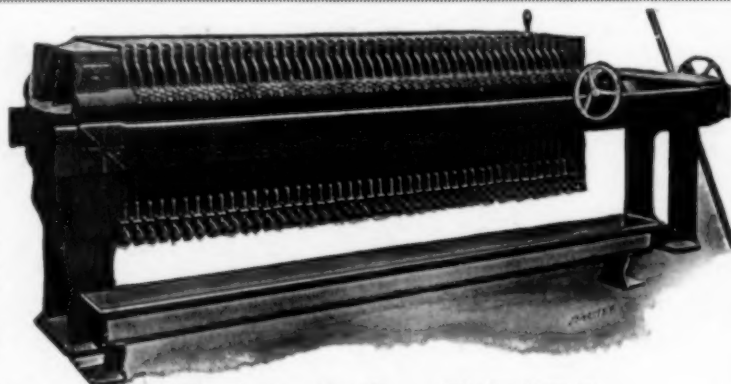


## For Big Production and Low Operating Cost SHRIVER FILTER PRESSES

They increase output and effect marked savings in filter cloth replacements and the recovery of values. Little attendance and less wash water adds to their economy.

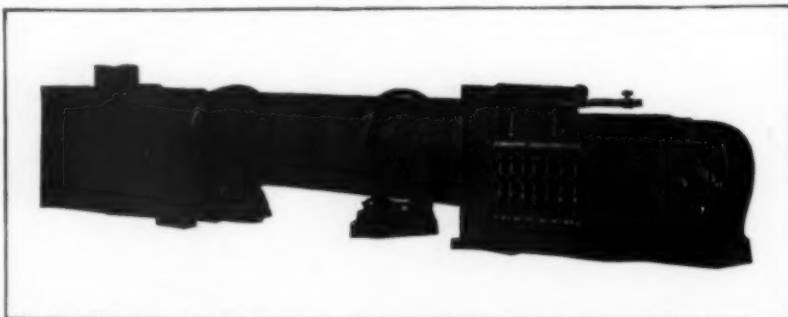
Have wide joint surfaces. Accurate finishing of plates and frames, coupled with an efficient tightening device, prevents leakage.

Presses for all industrial filtration. Small presses for laboratory work.



T. Shriver & Co., 808 Hamilton St.  
Harrison, N. J.

## STEAM HEATED AIR DRYERS



for drying Borax, Nitrate of Ammonia, Baking Powder, etc.

Have equipped largest chemical plants in the world.

Also Direct Heat Dryers for By-Products.

Material carried in stock for standard sizes.

**American Process Co.**  
68 William St., New York

## WHEN IN THE MARKET

Don't Forget that We Supply  
the Following Metals and Alloys

Ferro-Titanium, 25% Ti  
Chromium, 98-99% Cr.  
Ferro-Chromium, 60% Cr.  
Ferro-Vanadium, 40% Va  
Ferro-Molybdenum, 80% Mo  
Cobalt, 97%  
Tungsten, 95%  
Ferro-Tungsten, 70%

Manganese, Pure  
Manganese-Copper, 30/70%  
Manganese-Titanium, 30% Ti  
Manganese-Aluminum, 25% Mn  
Phosphor-Copper, 1% Phos  
Silicon-Copper, 10% Si  
Phosphor-Iron, 5% Phos  
Nickel-Copper, 50-50%

We are also in a position to quote on 50% Electro Furnace Ferro-Silicon manufactured by the Keokuk Electro Metals Company, of Keokuk, Iowa. This plant is now turning out a very high grade alloy, and, being centrally located, offers superior shipping facilities and freight rates. We represent this Company as exclusive selling agents.

Foundries making Brass, Bronze, German Silver, Nickel, Aluminum or composition castings should be sure to investigate our Pure Manganese and Manganese Alloys.

Ask for our pamphlet No. 2041.

## METAL & THERMIT CORPORATION

(Successors to Goldschmidt Detinning and Goldschmidt Thermit Co.)

THE EQUITABLE BUILDING, 120 BROADWAY, NEW YORK

Chicago—7300 So. Chicago Ave.  
San Francisco—329-333 Folsom St.

Pittsburgh—1427-1429 Western Ave.  
Toronto, Ont.—15 Emily Street

# CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

## McGRAW-HILL COMPANY, INC.

Tenth Avenue at 36th Street  
NEW YORK

JAMES H. McGRAW, President  
ARTHUR J. BALDWIN, Vice President E. J. MEHREN, Vice President  
EDWARD CALDWELL, Treasurer JAMES H. McGRAW, JR., Secretary

TELEPHONE, 2840 Greeley. CABLE ADDRESS, Machinist, New York

WASHINGTON, 1410 H. St., N.W. SALT LAKE CITY, Newhouse Bldg.  
CHICAGO, Old Colony Bldg. PHILADELPHIA, Real Estate Trust Bldg.  
SAN FRANCISCO, Rialto Bldg. CLEVELAND, Leader-News Bldg.  
LONDON, Hastings House, Norfolk St., Strand.

H. C. PARMELEE, Managing Editor  
ELLWOOD HENDRICK, Consulting Editor  
ERNEST E. THUM, Western Editor  
WALLACE SAVAGE, Assistant Editor

J. MALCOLM MUIR, Manager

Yearly Subscription price for United States, Mexico and United States dependencies, \$3; all other countries, \$4. Single Copy, 25c.

When change of address is ordered, the NEW and the OLD addresses must be given. Notice must be received at least 10 days before change takes place. No back copies for more than three months.

Copyright, McGraw-Hill Co., Inc., 1918. Entered as Second-Class Matter at the Post Office at New York, N. Y., under the Act of Congress, July 1, 1918.

Circulation of this issue 10,600 copies

## CONTENTS for October 15, 1918

Volume 19, Number 8

### EDITORIALS

The Fourth Liberty Loan and Victory.....	601
A Reconstruction Commission Should be Appointed Immediately.....	601
A Call to Save Paper.....	602
Deterioration of Reinforced Concrete.....	602
Germany's Finger in the Platinum Pie.....	602
Coke, Pig Iron and Transportation.....	603

### READERS' VIEWS AND COMMENTS

Effect of Oxygen on the Precipitation of Cyanide Solutions. By G. H. Clevenger.....	604
Germany's Finger in the Platinum Pie.....	604
Chemical Questionnaire Not a Call to Service.....	604
Refractory Tube Made in the Laboratory. By J. O. Bailar.....	605
Removing Plugs from Steel Drums. By M. E. Boyd.....	605
Honorary Doctorates at the Chemists' Club.....	605
The Western Chemical and Metallurgical Field.....	606
New Explosives Plant for California.....	607
Stringent Regulations on Platinum.....	607
Use of Perchloric Acid as a Substitute for Platinum in Potash Analysis.....	608
Fall Meeting of the American Electrochemical Society.....	609
The Use of Micro-Organisms in Chemical Industry. By Ernest G. Genoud.....	616
Reinforced Concrete vs. Salt, Brine and Sea Water. By H. J. M. Creighton.....	618
War Department Authorizes Construction of New Plants.....	623
Purloughs and Deferred Classification for Chemists.....	623
Carborundum Refractories.....	623
Imports of Rubber to January 1, 1919.....	623
Development of the Magnesium Industry. By Leonard Waldo.....	624
Housing at Tyrone, New Mexico. By Charles F. Willis.....	626
The Role of Colloids in Chemical Processes.....	630
Potash in Nebraska. By J. M. Litteras.....	633
Aluminum and Its Light Alloys—V. By Paul D. Merica.....	635
Thick Deposits of Electrolytic Nickel.....	640
Personal.....	641
Book Review.....	642
Current Market Reports—The Non-Ferrous, Iron and Steel and Chemical Markets and the Chemical Price List.....	642
Industrial News and Notes.....	647

## The Fourth Liberty

### Loan and Victory

SIX weeks ago we hazarded the opinion that the Fourth Liberty loan would be a victory loan. Events since that time have only strengthened that opinion. There is danger, however, that optimism will lead to procrastination in seeing the fourth loan through to a successful finish in the allotted time. It should be realized that if peace came tomorrow we have governmental obligations for billions of dollars that would necessitate the flotation of the loan. Victory may be in sight, and we hope it is, but we feel it necessary to caution against lethargy in supporting the Government at this time. Germany's ninth tyranny loan is likely to fail in the face of the disaster confronting her arms, but nothing should be allowed to slacken our pace or weaken our purpose with victory in sight. Failure to "double the third" in the campaign period would strengthen the morale of the enemy and give him cause for renewed hope. It would weaken and discourage our own troops who would be utterly unable to comprehend such a failure in the light of their own accomplishments. We cannot afford to fail, and we are confident we will not; but we believe emphasis should be laid on the magnitude of the undertaking and the necessity of redoubled effort on the part of all if success is to be our reward. We want to be able to say that we fought while they fought, and that we kept at it as long as they did.

## A Reconstruction Commission Should Be Appointed Immediately

THE American Electrochemical Society is the first of the national scientific and engineering societies to consider formally the post-war future of the industry which it represents. Elsewhere in this issue will be found a comprehensive report of the symposium on electrochemical industry in the United States after the war, as presented and discussed at the recent meeting of the Society. It directs our attention to the great necessity which has existed for months past for a national movement to prepare for the reconstruction of our industrial organization and its readjustment to peace conditions. Some time ago CHEMICAL & METALLURGICAL ENGINEERING, in common with all McGraw-Hill engineering publications, proposed a commission to be appointed by the President, to devote its entire time and energies to the reconstruction problem. The subject was considered in detail, and the foundation was laid for the organization. There was no immediate response; but recently we have noted urgent appeals for national attention to the problem, and the introduction of several bills in Congress providing for commissions



to arrange for the transition of our industries.

The United States cannot act too soon. We have pointed out before that the other belligerent nations have long since had their commissions at work; that every other nation of importance has made more progress than we in formulating its problems and discovering their solution. We have been as slow to comprehend post-war conditions as we were to enter the conflict. But conditions in the two instances are different: there was someone to battle for us until we got our fighting clothes on, but there will be none to solve our problems when the conflict is over. Each nation will then be busy with its own affairs, and properly so.

There are two types of commission that can be created to study and handle the matter, one legislative and the other executive. We are unqualifiedly in favor of the latter. Legislative commissions are notoriously inefficient. They have a political cast and a political point of view. Their responsibility is indefinite, their qualifications doubtful. In legal talent they abound, but it is questionable whether they comprehend the problems of employment, production, distribution, and foreign and domestic commerce. A commission of executive appointment, on the other hand, could be created with a special view to its fitness for the great task. Leaders of industry and labor, economists and engineers, experts and specialists could be drafted by the President for such a commission. Its responsibility would be definite, its purpose unhampered by political considerations. Its findings would be guide-posts for industry. We understand that bills for both types of commission have been introduced in Congress. We express the hope that no legislative commission will ever be created, but that one of executive character will speedily come into being. The events of the past few days shows how near the end of the war may be; and the nearer the end, the farther we are from solving our problems.

### A Call to

#### Save Paper

**P**ROBABLY one of the most thoughtless wastes in our daily life is the destruction of paper—newspaper and wrapping paper in the home, envelopes and writing paper at the office, magazines everywhere. Ordinarily this waste has passed unheeded, but today we look behind the product of the paper mill to the supplies needed for manufacture, and we visualize paper in terms of coal for power, caustic soda for pulp, chlorine for bleaching, and man-power for operation of the plant. All these commodities are needed for war service in the most direct manner, and consequently they are rationed to the paper industry. Paper, in turn, is rationed to those who buy from the mills. But it is a material of universal use, and its conservation becomes a duty incumbent on the most humble consumer. Methods of conservation are simple and obvious if we but stop and think. Ordinarily but one surface of a sheet of writing paper is used, and while we cannot endorse the universal practice of writing on both sides, we believe there is a big opportunity for saving there. Envelopes can be used for scratch paper, and large manila envelopes can be used over and over again by the simple expedient of pasting a new address over the old one. Waste paper of all kinds can be salvaged and sold to dealers.

### Deterioration of Reinforced Concrete

**S**OME time ago the U. S. Bureau of Standards reported the action of electric current on iron bars embedded in concrete. Layers of iron oxide formed at the anode with an accompanying expansion in volume of 220 per cent of the iron oxidized, which gave rise to a mechanical pressure sufficient to crack the concrete. At the cathode the concentration of sodium and potassium had a softening effect on the concrete, which became brittle and friable. Elsewhere in this issue, an excellent account is given of several cases of serious structural deterioration due to the corrosion of the reinforcing bars in the presence of salts. The origin of the electromotive force may be assigned to several causes but great differences in concentration of the electrolyte due to evaporation of the solution at the surface of the concrete may exert a considerable proportion of the potential. Exhaustive studies of this corrosion are being made. It is fundamental to modern engineering practice that means for overcoming it should be found at once. The domains of the chemical and civil engineers overlap here and it is incumbent on the former to use his most efficient research methods and find the solution of the problem.

Ordinary rust-proofing methods are not available except for a limited use of paint, which has certain serious defects. Less porous concrete can certainly be had by proper control of the batch mixes—the water content being the most abused. Allowance should also be made for actual drainage of the liquid portions from the aggregate—the 1:2:4 etc. rule being too limited for supplying the varying requirements found in actual practice. Honeycombed pours are not rare and subsequent plastering-over neither protects the metal reinforcements from the weathering agencies nor does more than deceive the observer as to its quality. The addition of mineral soaps and oils on a large scale would be a serious item of cost in rendering all concrete waterproof. Certain mineral colloids seem to offer an excellent means of cutting down the volume of pore space. However, while chemists and engineers seek a means of checking the corrosion, why not change the design of reinforcements so that this internal pressure will not have to be counteracted by the low tensile strength of concrete? A trial might be made on heavy rolled metal fabricated with a pipe machine but not welded at the lap. Lateral strains produced by the increment in volume of the reinforcements due to rust would be absorbed by deflecting the tubular bars.

### Germany's Finger In the Platinum Pie

**E**DITORIAL comment under this caption in our issue for August 15 has been the subject of some criticism, particularly as relating to Mr. Charles Engelhard and his business associates. Needless to say, our opinion then expressed was based on what we believed to be authentic and reliable information. As to that part of our remarks suggesting the possible influence of Mr. Engelhard in fixing the price paid by our Government for some 20,000 ounces of platinum brought from Russia, he himself has already entered a denial which we have published and accepted at its face value.

Since that time we have had an opportunity to gain



additional information from sworn statements of Mr. Engelhard, in which he disclosed the details of his relations with the German house of Heraeus and the former interest of Heraeus in the American Platinum Works and Baker & Co. These affidavits show that the German interest in these American platinum corporations, as represented by Heraeus, amounted at one time to 20 per cent, but that about April 1916, or nearly one year prior to our declaration of war with Germany, Mr. Engelhard acquired the entire Heraeus interest in the two companies. Since that time it appears that there has been no enemy or ally-of-enemy interest in either of them. We are further advised that Mr. Engelhard has caused a minute to be entered on the records of the several companies in which he is interested, to the effect that he will not reconvey any stock to Dr. Heraeus at the close of the war, without the unanimous approval of all the stockholders of record.

It appears that Mr. Engelhard has been fully investigated on these points, as well as on his entire business career in this country, by several branches of the Government. Unfortunately the Government does not officially announce the results of such investigations nor publicly state its opinion regarding the loyalty of the individuals investigated. As one official explained it to us, the evidence is presumptively in the individual's favor if no action is taken against him. Thus, while we have been unable to secure from any official or agent of the Government any statement as to the result of the investigations, we presume it was favorable to Mr. Engelhard and satisfactory to the Government. Since there was no malice in our original remarks nor any desire to do an injustice to Mr. Engelhard, we are glad to correct any false impression we may have created as to his loyalty or the German control of his companies.

### Coke, Pig Iron and Transportation

PRODUCTION of pig iron in the first half of 1918 is officially reported at 18,227,730 gross tons, which is more than a million tons less than the production in any one of the four preceding half years, and 1,600,000 tons less than the production in the latter half of 1916. The blast-furnace capacity had meanwhile undergone a very considerable increase. The failure in production in the first half of this year was due to shortage of coke and the shortage of coke was due to the railroad breakdown whereby by-product coke production was curtailed materially and beehive coke production curtailed a great deal. All the loss in pig iron production occurred during the first quarter of the year. Production in the second quarter was more than 10,000,000 tons, or at a rate greater than obtained in any preceding half year. Production in the third quarter was substantially the same, and production in the current quarter promises to be much heavier.

The Railroad Administration insists that there is not the least likelihood of a railroad breakdown this winter at all comparable to that of last winter and no doubt the balance of probabilities lies strongly in that direction. The railroads are much better organized, the shipments are much better controlled so that they do not tend to produce congestion as they did a year ago,

and a repetition of last winter's altogether exceptional weather is of course unlikely.

Even though pig iron production conditions have been much less unsatisfactory in recent months than in the first three months of the year they have not been really satisfactory by any means, as the output has not been as much as would be expected from the capacity of the furnaces in blast. A thorough investigation of the matter was undertaken nearly two months ago and the blast furnaces laid most of the blame on the character of the coke they were receiving, there being much coke of poor structure and much coke with too much ash, the former indicating carelessness in burning, the latter carelessness in mining. The Fuel Administration accordingly inaugurated a strenuous campaign to bring about the production of coke of better quality, and some results have lately begun to be apparent.

The importance of coke quality cannot be overestimated. The production of coke has been approximately equal to the requirements of the blast furnaces for months past, the cases of coke shortage being few and far between. Better coke means more pig iron per furnace, and as a total. More pig iron means more steel, for the steel works are not fully supplied with pig iron in relation to their capacity, and every ton of steel helps to win the war. The control of steel by the War Industries Board, rigid for several months and constantly growing more rigid, insures that every additional ton of steel made will be placed where it will do good.

The production of by-product coke has increased even more rapidly than was expected. In this department two months ago there was a survey of the situation as to the completion of by-product ovens, and it was estimated, conservatively, that by the end of the year there would be 615,000 net tons per week rated capacity in by-product coke, which with a 90 per cent efficiency, about what had been shown in the past, would mean an output of 550,000 tons a week. Two months later, however, we have the Geological Survey report for the week ended September 28, showing a rated capacity of 624,910 tons, a production of 576,254 tons, and a proportion of production to rated capacity of 92.2 per cent. This high percentage was probably fortuitous, for every one of the separate causes of loss was exceptionally low—coal shortage, labor trouble, repairs and miscellaneous. In the same week the production of beehive coke was 612,000 tons, making a total of 1,188,000 tons of coke produced in the week, representing a rate of 62,000,000 tons a year.

The normal function of a by-product coking plant is to make coke as a product and certain other things as by-products. That is not precisely the alignment in war time. The Clairton plant in the Pittsburgh district, where seven batteries of 64 ovens each are now in operation, with three more batteries to follow very shortly, is operating on high volatile coal from the Klondike region, when physical conditions would permit the use of the lower volatile coal of the Old Basin, because the output of toluol and sulphate of amonnia is correspondingly increased. On 19 hours' coking time the plant is showing 1,000 tons coal consumption and 650 tons coke production per battery per day. The Old Basin coals run 70 per cent and upwards while the Klondike coals are all well below 70 per cent.

## Readers' Views and Comments

### Effect of Oxygen on Precipitation of Cyanide Solutions

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—In the September 15th issue of CHEMICAL & METALLURGICAL ENGINEERING, in the discussion of Mr. Thomas B. Crowe's paper on "The Effect of Oxygen Upon the Precipitation of Metals from Cyanide Solutions," I note that you attribute the following remarks to me:

"Chairman Clevenger said that without endeavoring to detract from Mr. Crowe's work in the least he thought that the same thing had been done inadvertently in vacuum filtering, in the Butter's type machine, for many years."

This statement as it appears could readily be construed as meaning that although unconscious of what they were doing all operators of vacuum filters had removed the air from their cyanide solutions prior to precipitation. Furthermore, it might be assumed that Mr. Crowe's development lacked patentable novelty.

My introductory remarks as taken from the stenographic report of the meeting were as follows:

"I am sure that Mr. Crowe's paper will prove of a great deal of interest to cyanide operators as it is a distinct new development in cyanidation. After reading the paper, it occurred to me that some of us had done practically the same thing sometime ago, but that we had done so without design and unconsciously. I refer particularly to the operation of some of the earlier types of vacuum filter with which was used a dry-vacuum pump and a receiver. This is similar equipment to that employed by Mr. Crowe, and it is obvious that all solution passing through the filter under this condition would have its air removed."

"However, we did not know the good effects that we were getting from such of this solution as was precipitated, and it has remained for Mr. Crowe to bring sharply to our attention the advantages of removing air from cyanide solutions prior to precipitation. I feel sure that we will all give him full credit for this clever improvement in the cyanide process."

During the discussion the further observation was made:

"It is the case of one of those obviously simple things when you see it in operation, yet something that we have all overlooked despite the fact that we have operated vacuum filters."

It will be noted that I referred particularly to the operation of some of the earlier types of vacuum filters with which was used a dry-vacuum pump and receiver. As a matter of fact the dry-vacuum pump and receiver were discontinued for later installations in favor of the wet-vacuum pump, on account of the greater simplicity of the arrangement, there being required no receiver, and so-called barometric leg for continuously discharging the solution from the receiver without breaking the vacuum.

It is obvious that in installations employing the wet-vacuum pump little or no air would be removed from the solution. In installations employing the dry-vacuum pump the air was removed only from such solution as passed the filter. In the operation of filters of all types it has been long recognized that thick pulp can be most efficiently filtered; or, in other words, the smaller the proportion of the solution which it is necessary to force through the filtering medium in forming the

cake, the greater the capacity of a given unit. The whole of the pregnant solution precipitated was, therefore, never passed through the filter. Practice regarding the proportion of solution from the filter which was precipitated varied. In many cases the amount of such solution precipitated was small, and in some cases none of it was precipitated.

On the whole it is, therefore, clear that in vacuum filtration as practiced in recent years, no benefit has been derived through the removal of air from solutions passing the filter.

Mr. Crowe has been the first to point out that it was advantageous to remove dissolved air from pregnant solutions prior to precipitation, and acting upon this knowledge he has been the first to apply a vacuum to all the pregnant solution prior to precipitation. Therefore, there can be no question regarding the originality of his invention.

G. H. CLEVANGER.

Colorado Springs, Colo.

### Germany's Finger in the Platinum Pie

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—Our attention has been called to the editorial in your issue of August 15, entitled "Germany's Finger in the Platinum Pie" and we wish to protest against the statements made therein so far as concerns our firm.

As you may know, we have acted as agents for the British Government in regard to platinum during the war.

Your statement that "Heraeus also is said to have owned a one-fifth interest in Johnson Matthey & Co.," is wholly incorrect. Neither Heraeus, nor any German individual, partnership or corporation owns or at any time has owned any interest whatsoever in Johnson Matthey & Co. Our stock is and has always been held exclusively by British proprietors.

JOHNSON MATTHEY & Co., LTD.

London, England.

### Chemical Questionnaire Not a Call to Service

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—General Sibert directs me to extend to you the thanks of the Chemical Warfare Service of the United States Army for your assistance in the census of American chemists recently made by this arm of the service. Without the aid of your journal it would have been impossible to have gained such wide publicity for the enterprise, or to have obtained such a prompt and altogether satisfactory response from the great body of loyal chemists of this country. Well over half the questionnaires have been answered within the first three weeks of the campaign, and the rest are daily being received in such numbers as to indicate the completion of the task at a not far distant date. The War Department is thus put in possession of an invaluable set of records at extremely small expense.

While the purpose of the questionnaire has been understood by nearly all of those who have replied to it, there have been a few instances in which it has been mistaken-



ly interpreted as a call to immediate service. In order to avoid any misunderstanding it should be explained that the purpose of the census is primarily to put the War Department in control of complete information as to the chemical man-power of the country, not to gain immediate recruits for the Chemical Warfare Service. At the present time the vacancies in the Service are comparatively few in number. When vacancies occur in the future, reference will be had to the tabulated information gleaned from the present census, and appointments will be made from the names on file, attention being paid to the applicant's technical qualifications, desire to serve, etc.

The great majority of American chemists will undoubtedly never be called upon to serve in a military capacity in the present war. The Government, however, must have complete information concerning all chemists, in order that it may select those best fitted to perform its work, and at the same time interfere as little as possible with established essential industries. The chemist who, after returning his completed questionnaire, receives no call to service may take it for granted that the Government cannot, for the time being, utilize his services. In the meantime three things are asked of him:

1. To keep the Chemical Warfare Service informed of any change in his address, his employment, his draft status or anything else which might have a bearing on his case.

2. To notify the Chemical Warfare Service at once if he is drafted and called to camp. In such a case he should give his complete military address.

3. To help stabilize the industry of the country by continuing steadily at essential work until the Government notifies him that his services are needed elsewhere.

In addition it is requested that all persons send to the Chemical Warfare Service the names and addresses of any chemists of their acquaintance who have not already received the questionnaire. Chemists who have already received the questionnaire but who have not yet returned it should do so *at once*, in order that the Government may not be put to the trouble of sending out a large number of follow-up letters. Any chemist who has not received the questionnaire should write for a copy, addressing his request to the Personnel Section, Administration Division, Chemical Warfare Service, U. S. A., 7th and B Streets, N.W., Washington, D. C.

F. E. BREITHUT,

Major Chemical Warfare Service,  
Chief of Personnel.

Washington, D. C.

### Refractory Tube Made in the Laboratory

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—A research chemist of the writer's acquaintance recently found it necessary to use a refractory tube of dimensions not carried in stock by any of the dealers of his locality. Being put to the necessity of making what he wanted he proceeded as follows:

Calcined fire-clay ground to pass a fifty-mesh screen was mixed to a paste of such consistency that it could be poured with difficulty. An iron pipe of the desired dimensions was filled with this clay and after shaking until the clay was thoroughly stuck to the pipe the excess was poured out. The pipe was then placed in a

horizontal position and turned slowly until the clay was set. This required but a few minutes. When the clay was set the pipe was attached to an aspirator and a gentle current of air was drawn through the pipe until it was dry; it was then placed in the furnace and burned at the proper temperature, when it was ready for use. This pipe gave perfect satisfaction and was good for any temperature to the melting point of iron. The lining was used to protect the iron from the materials used in the experiment.

JOHN C. BAILAR.

Golden, Colo.

### Removing Plugs from Steel Drums

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—Frequently the threaded plugs in steel drums, especially those containing corrosive chemicals, offer such resistance when an attempt is made to remove them that a cold chisel and hammer have to be resorted to. This usually renders the drum worthless for further use, and if the contents are not used immediately, they must be transferred to another container.

This trouble can be obviated by a simple method which can be applied with the ordinary tools around a plant. When the usual methods fail to remove the plug, if a slot is sawed through the center of it with an ordinary hack saw and several sharp blows struck at right angles to the slot with a hammer, and a large pipe wrench applied, the plug will come out easily. The slot allows the plug to yield sufficiently to loosen the threads and does not spoil the plug for use.

M. EDWARD BOYD.

Washington, D. C.

### Honorary Doctorates at the Chemists' Club

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—William, he of the dusky countenance and ample girth who erstwhile greeted the members of the Chemists' Club as they entered its portals, has passed away. For a year or more there had been trouble, sometimes with his health, sometimes with his disposition, and as a sequence of the latter irregularity there followed occasional measures of reproof from the house committee. But these are all at an end now and it is our pious hope that clad in golden slippers his airy steps are guided along the jasper streets by Old Black Joe, Uncle Ned, the lovely Nellie Gray and Aunt Dinah of the Quilting Party from the Old Kentucky Home. Perhaps he may even find an abundance of those Kentucky spirits which in life he loved too well and which we shall soon seek in vain.

His memory will always be distinguished because it was he who founded, originated and impersonated the only institution that conferred an honorary doctorate upon every member of the Club. Some of these were merely confirmatory of academic honors already achieved either at home or abroad, and as such they call for no comment. Others again were wholly original and preceded the titles which are anticipated every June, *honoris causa*, by a vast number of the chemists of America. William was the pioneer in these endowments of the mind. To him, every person elected became a Doctor as soon as he qualified in his membership. These titles were known as William's College Degrees.

E. H.

New York City.

## Western Chemical and Metallurgical Field

### Smelting in British Columbia

The dormant investigation of British Columbian smelter schedules authorized by the Dominion Government but halted by lack of funds, will probably be revived by lead-ore shippers following the increase of 45 cents per ton under Schedule B announced recently by the Trail Smelter. S. G. Blaylock, the assistant general manager of the smelting company, in a letter to producers, cites the following increases in smelting expense causing the increase:

Cost of coke increased 40 cents per ton at ovens, equalling an increase of 10 cents per ton on ore.

Wages increased 30 cents per shift, equalling an increase of 45 cents per ton on ore.

Increases in freights on both coke and bullion also went into effect at about the same time, so that in addition to the above increase, all settlements will be reduced by the actual increase in transportation cost.

The Grand Forks smelter of the Granby Consolidated Co., has been shut down. Its closure has been foreshadowed for a year or more by the rapidly increasing costs of mining and smelting and the decreasing tenure of ore received from the Phoenix mines, its main source of supply. Operations at Grand Forks have therefore gradually been curtailed. The recent increase in the price of copper was absorbed immediately by increased freight and labor costs. Consequently the main operations of the Granby Company have shifted to the coast, where the Anyox smelter, handling ore from the Hidden Creek mine, is producing a large amount of copper at a much lower cost.

The Ladysmith smelter has recently indulged in another short campaign, but rapidly exhausted the accumulation of ore on hand. Operations of this sort are today somewhat of an anachronism, reminiscent of the times when blast-furnace operations were controlled by the fracture of slag and matte buttons.

Meanwhile, the Provincial Government has taken an active interest in the exploitation of their large resources in iron ore. Alfred Stansfield has spent the summer investigating the possibility of smelting these ores in the electric furnace, and his report is awaited with much interest by the entire Pacific Coast. Without anticipating his findings, it may be stated that electric pig iron probably could be financed by Californians if gray iron could be produced, lower in silicon and higher in graphitic carbon than the usual electric pig. The latter is not acceptable to the foundrymen in that region, although it is excellent material for steel furnace. Electric steel in competition with open-hearth products merchant and structural shapes would require energy at a cost per kilowatt-hour but a fraction of any present quotation in that region.

**Porphyry Coppers Summary.**—A tabular representation of the performance of the various mills at Utah Copper, Chino, Ray and Nevada Consolidated for the year 1917 is given herewith, together with a comparison of the results for the preceding year. The costs in every case show large increases. Except in the case of Nevada Consolidated they seem to be figured on the same basis and allow for smelter deductions, are

credited with precious metal values and miscellaneous income, are charged with all overhead charges, transportation, refining and selling costs, 5 per cent for depreciation, and a large reserve estimated to cover Federal and other taxes to become due in the immediate future.

The low recovery of the mills of the Utah Copper Co. is said to be due to the use of a lower grade ore than usual, interference by reconstruction in the plants themselves, and to the crowding through of a maximum tonnage (they are running 60 per cent over their normal economic capacity). The revision of the fine-crushing department at the Magna Plant continues slowly. Much work was done at the Arthur Plant. The fine-grinding department was reconstructed and new facilities installed for handling concentrates and tailings. The construction of a new tailings dam covering a largely increased area below the mills and necessitating the revision of several miles of main line railway track was rapidly pushed. The leaching plant was completed, and was being started up at the end of the year. A new coarse-crushing department was designed in order to eliminate delays in handling frozen cars in winter, consisting of a car tippie and a very large crusher, together with the necessary auxiliaries.

At Hurley, New Mexico, additions to the concentration machinery in the original five sections of the Chino mill were completed about the middle of the year, and with the second unit of the crushing plant in operation at Santa Rita an additional tonnage of 11 per cent was immediately treated. The construction of Section 6 was nearly completed, and a flow sheet for Section 7 (to handle 500 tons of oxidized ores in addition to a large amount of sulphides) was worked out from the operation of the 100-ton experimental plant. The good results to be expected from the oxide mill caused the abandonment of further construction of the tailings retreatment plant.

At the Ray concentrator at Hayden, Arizona, an increased copper recovery of 18 per cent was effected on but a 7 per cent increase in ore treated. This result was effected by methods worked out largely by the local

STATISTICS OF JACKLING PROPERTIES

	Utah Copper Magna	Utah Copper Arthur	Chino	Ray	Nevada Consolidated
Ore milled, tons.....	7,077,200	5,464,800	3,608,100	3,560,900	4,064,095
Change, per cent....	+15.2	+12.7	+16.9	+7.2	+2.8
Copper content, per cent.....	1.377		1.64	1.635	1.462
Change.....	-0.098		-0.19	+0.028	-0.170
Recovery, per cent..	61.1		69.32	74.53	73.08
Change.....	-1.24		+2.73	+2.33	-0.79
Milling costs, cents per ton.....	62.28	78.40	103.0	82.86	74.8
Change, per cent..	+26.93	+37.46	+39.0	+27.51	+18.9
Pounds copper in concentrates.....	204,855,118		81,925,809	92,207,356	86,834,271
Change, per cent..	+4.1		+8.44	+18.0	-11.2
Average grade, concentrates, per cent.....	16.615		15.47	18.935	7.673
Change.....	-2.099		+0.65	-0.979	.....
Copper in smelting ores.....	1,319,324		1,413,973	5,409,770	.....
Costs, cents per pound.....	10.952		11.39	12.141	10.84
Change, per cent..	+4.034		+2.69	+2.007	+2.71

staff, increasing the efficiency of all departments of the plant. During the year a new system of slimes treatment was developed and installed to give final recoveries on 75 per cent of the total tonnage. The recovery of sulphide copper in Ray ores amounts to 83.32 per cent, but only 33.48 per cent of the contents in oxide- and carbonate-copper is saved.



Three-quarters of a million dollars in new construction was expended at the plants of the Nevada Consolidated, mainly for a new crushing plant at the mill, and a plant for pulverizing coal to replace oil as a fuel in the reverberatory furnaces. The coarse-crushing division of the mill now delivers the entire mill tonnage at about 1-inch size, this relieving the fine-crushing departments of their overload. Tube mills have also been installed in the regrinding sections. The recovery of copper from company ores shows a sharp decrease; but as a matter of fact the copper produced in concentrates by the mill was about the same as before, the balance being made up from ores treated on a custom basis.

#### Ore-Dressing Activities of the Bureau of Mines

THE Salt Lake station of the Bureau of Mines is about to occupy a substantial office and laboratory building, erected at a cost of about \$35,000, at a spot alongside the present ore-dressing laboratory. The new building was made possible largely by the coöperation of several mining companies in Utah, who donated perhaps half of the funds for its erection. Besides offices for the superintendent, metallurgist, chemist, and their clerical help, it will contain the laboratories for chemical and microscopic analysis, together with a large library. The University of Utah benefits from the erection of the building by having office quarters for the head of the metallurgical department, as well as a large lecture room at the north end of the building. Thomas Varley has been transferred from the Seattle station to become acting superintendent of the Salt Lake station, where it is possible that the ore-dressing work of the Bureau will become centralized. The present milling equipment, which is unusually complete, suffers in that it requires a considerable tonnage of ore upon which to operate. Consequently the apparatus is being rearranged and remodeled so that lots of a few hundred pounds can be efficiently studied. Mr. Varley has been succeeded in Seattle by Mr. F. F. OVITZ, Fuel Engineer. Work at that point will consist largely of fuel investigations under the direction of the superintendent, and electro-metallurgical work directed by Mr. F. C. RYAN.

#### New Explosives Plant for California

The erection of a TNT plant at Giant, Cal., has been authorized. The estimated cost is \$1,438,000. This plant is to be located on land adjacent to the nitric acid plant of the Giant Powder Company, located at Giant, Cal. The land belongs to the powder company and is to be leased to the Government with option on the part of the Government to renew in yearly periods. The government is to remove the plant whenever it feels that the plant's further maintenance is unnecessary. The contractor will be Grant Smith and Company, of Seattle, Washington. The construction work is to be under the supervision of the Construction Division of the Army. The finished plant will be operated by the Giant Powder Company.

Ninety-day contracts can now be made by manufacturers of sulphuric, nitric and muriatic acids through 1919, giving the government preferential rights if needed for its war requirements at the schedule prices.

## Stringent Regulations on Platinum

WHILE no reliable data has ever been available on platinum production, because much of the Russian output has intentionally not been reported in order to avoid taxes, Prof. J. L. Howe has recently estimated the limits of production in the world up to January 1917 in troy ounces as:

	Minimum	Maximum
Russia .....	7,115,482	10,128,308
Colombia .....	700,000	735,000
Borneo .....	175,000	200,000
United States .....	10,000	12,000
Canada .....	9,000	10,000
Miscellaneous .....	9,000	12,000
	8,018,482	11,095,308

About 10 per cent of the above is undoubtedly in the United States, but how it is distributed and utilized is not known. Since the catalytic process plants for manufacturing sulphuric and nitric acids are being installed on such a large scale, it is estimated that about 12 per cent of our million ounces of platinum will be used in the 3,000,000-ton catalytic vitriol output. One ounce of platinum is needed for the production of twenty-five tons of catalytic sulphuric acid or forty tons of nitric acid from ammonium per annum.

Now that the Russian supplies are shut off, it has become important that our scattered domestic stocks be inventoried, so that if the need should arise, requisitions can be taken efficiently and with the least hazard to scientific development. Mr. C. H. Conner, chief of the platinum section of the War Industries Board, wishes it known that it is desired to disturb the trade as little as possible but that the co-operation of all citizens in the enforcement of the platinum regulations is essential:

#### REGULATIONS.

The following regulations are hereby promulgated under the provisions of the act of October 6, 1917 (40 Stat., 385), as amended by the act of July 1, 1918 (Public, No. 181), authorizing the Director of the Bureau of Mines, under rules and regulations approved by the Secretary of the Interior, to limit, during the period of the war, the sale, possession, and use of platinum, iridium, and palladium, and compounds thereof:

SECTION I. The War Industries Board is hereby designated under section 21 of the act of October 6, 1917, and the President's proclamation of October 26, 1917, as the agent of the Director of the Bureau of Mines in the execution of the regulations as hereinafter indicated.

SEC. II. From and after the date of these regulations, under the penalties prescribed by section 19 of the act of October 6, 1917, no person shall:

PAR. a. Use any platinum or platinum scrap, iridium, or iridium scrap, palladium or palladium scrap, and/or compounds thereof, in the manufacture, alteration, or repair of any ornament or article of jewelry.

PAR. b. Manufacture for use in dentistry any metal, metal parts, or alloys containing more than 20 per cent by weight of platinum or 40 per cent by weight of platinum, iridium, and/or palladium combined, or manufacture supplies therefrom.

SEC. III. From and after the date of these regulations, under the penalties prescribed by section 19 of the act of October 6, 1917, no person shall without a license—

"Section 19 of the act of Oct. 6, 1917, is as follows: "That any person violating any of the provisions of this act, or any rules or regulations made thereunder, shall be guilty of misdemeanor, and shall be punished by a fine of not more than \$5,000, or by imprisonment not more than one year, or by both such fine and imprisonment."

"The word 'Person,' for the purposes of these regulations, shall be construed in accordance with the definition contained in section 4 of the act of Oct. 6, 1917, which is as follows:

"That the word 'person' when used herein shall include States, Territories, the District of Columbia, Alaska, and other dependencies of the United States, and municipal subdivisions thereof, individual citizens, firms, associations, societies, and corporations of the United States and of other countries at peace with the United States."

PAR. a. Purchase, sell, barter, or deal in unmanufactured platinum, iridium, or palladium, or compounds thereof (including crude, scrap, filings, polishings, or sweeps), except that sales may be made without a license to an authorized agent of the United States or to a licensee authorized to purchase the same; or possess for more than 90 days after the date of these regulations one ounce troy, or more, of such unmanufactured platinum, iridium, palladium, or compounds thereof.

PAR. b. Possess, use, sell, purchase, or barter, for purposes connected with his business, platinum, iridium, palladium, or compounds thereof (except that sales may be made without license to an authorized agent of the United States, or to licensee authorized to purchase the same), if such person be engaged in—

No. 1. Producing platinum, iridium, or palladium, or compounds thereof, by mining.

No. 2. Producing sulphuric acid, nitric acid, or other chemical products where platinum, iridium, palladium, or compounds thereof are used in such production.

No. 3. Importing or exporting platinum, iridium, or palladium, or compounds thereof.

No. 4. Producing platinum, iridium, or palladium, or compounds thereof, either as a primary product or as a by-product of smelting or refining.

No. 5. Manufacturing electrical appliances and/or parts thereof containing platinum, iridium, or palladium, or compounds thereof.

No. 6. Manufacturing surgical appliances and X-ray apparatus containing platinum, iridium, or palladium, or compounds thereof.

No. 7. Manufacturing chemical apparatus and reagents of all kinds containing platinum, iridium, or palladium, or compounds thereof.

No. 8. Conducting or operating chemical laboratories in which platinum, iridium, or palladium, or compounds thereof, are used.

No. 9. Manufacturing scientific instruments containing platinum, iridium, or palladium, or compounds thereof.

No. 10. Manufacturing and/or distributing dental supplies containing platinum, iridium, or palladium, or compounds thereof.

No. 11. Manufacturing and/or dealing in jewelry containing platinum, iridium, or palladium or compounds thereof.

No. 12. Manufacturing or producing any article or product not mentioned above where such business requires more than one ounce troy per month of platinum, iridium, or palladium or compounds thereof.

SEC. IV. Applications for licenses shall be made under oath to any licensing agent duly authorized under the act of October 6, 1917, as provided in the regulations issued under this act.

SEC. V. Every applicant for license will be required to submit with his application a sworn inventory of all platinum, iridium or palladium or compounds thereof in his possession or control; and every licensee will be required to submit at such times as may be designated by the War Industries Board a sworn inventory of his holdings of platinum, iridium, or palladium or compounds thereof in whatever form they may be.

The Director of the Bureau of Mines, at the request of the War Industries Board, may at any time require from any user or possessor a detailed sworn inventory of any and all materials held by him containing platinum, iridium, palladium or compounds thereof, and such inventory must be furnished promptly upon receipt of such requirement.

SEC. VI. All licenses shall be issued in the name of the Director of the Bureau of Mines and countersigned and delivered by the War Industries Board, and shall be, and remain subject to the following conditions:

PAR. a. Each license shall contain such appropriate conditions as the Bureau of Mines, through the War Industries Board, may impose.

PAR. b. The Bureau of Mines through the War Industries Board may change the conditions of the license from time to time, as it may deem necessary.

PAR. c. Records shall be kept by each licensee of all his sales, purchases and other transfers of platinum, iridium or palladium or compounds thereof, and of articles containing platinum, iridium, or palladium or compounds thereof, with the names and addresses of the purchasers, sellers, and/or transferees, and the quantities involved, which records shall be open at all times to the duly authorized representative of the Director of the Bureau of Mines.

PAR. d. Any and all platinum, iridium, or palladium, or compounds thereof, acquired under the authority of such license shall be used strictly for the purposes and in the manner stated in such license.

PAR. e. Upon request of the War Industries Board, the licensee shall report the prices at which sales of his products containing platinum, iridium, or palladium, or compounds thereof, are being made; and the right to prohibit further sale of such articles at prices deemed exorbitant by it is reserved to the War Industries Board.

SEC. VII. Any licenses issued hereunder may be revoked for violation of any of these regulations, or for violation of any of the conditions contained in such license, or if such revocation is deemed necessary or advisable for purposes of the national security and common defense.

SEC. VIII. The War Industries Board will, upon request, furnish a list of Government agents or licensees authorized to purchase platinum, iridium, or palladium, or compounds thereof. Neither the United States nor its representatives will assume any responsibility, financial or otherwise, where sales are made to licensees.

SEC. IX. The prices at which platinum, iridium, or palladium will be purchased by a duly authorized agent of the United States or by such licensee as may be authorized to purchase or sell platinum, iridium, or palladium, or compounds thereof, will be such prices as may be determined by the proper governmental agency authorized to determine such prices.

SEC. X. Whenever such Government agents and such licensees as may be authorized to purchase platinum, iridium, or palladium or compounds thereof, shall refuse to purchase the same from any person who is compelled by these regulations to sell the same, or is forbidden by these regulations to possess or use the same, then such person shall promptly notify the Platinum Section, War Industries Board, Washington, D. C.

SEC. XI. These regulations shall not operate to relieve any person upon whom an order requisitioning platinum, iridium, or palladium or compounds thereof may have been or may hereafter be served, from any obligation imposed upon him by such order.

SEC. XII. These regulations are supplemental and amendatory to the regulations heretofore issued under the Explosives Act of October 6, 1917.

VAN. H. MANNING,  
Director of Bureau of Mines.

Approved, August 17, 1918.

FRANKLIN K. LANE,  
Secretary of the Interior.

### Use of Perchloric Acid as a Substitute for Platinum in Potash Analysis

Precipitate the sulphates present with barium chloride (slight excess) in strong HCl solution, boil and filter off the barium sulphate, if present. Evaporate to dryness and heat until all ammonium salts are driven off—below, red heat so as not to volatilize any KCl. Dissolve in 20 cc. hot water and add a quantity of HClO<sub>4</sub> sufficient to combine with all bases present. Evaporate without stirring, cool, and dissolve residue in hot water. Add HClO<sub>4</sub>, and again evaporate until the heavy white fumes of perchloric acid are given off. Be sure to cool. Take up with 25 cc. 96-97% alcohol containing 0.2% by weight of HClO<sub>4</sub> (1 cc. 60% acid per 300 cc. 97-98% alcohol), breaking up residue with stirring rod. Decant through a weighed Gooch crucible containing a mat which has been washed with the above wash alcohol. Wash once again with the wash alcohol, decant, and transfer the filtrate to the crucible. Wash several times with wash alcohol, dry for an hour at 120-130° C., cool and weigh. The residue is KClO<sub>4</sub>. Dissolve this off with hot water and the crucible is ready for another determination. The accuracy should average between one-half and one-tenth of one per cent.



## Fall Meeting of the American Electrochemical Society

The Principal Feature of the Meeting Was a Symposium on Electrochemical Industries After the War, in Which Specialists Discussed Various Post-War Problems—Meetings for 1919 Will Be Held in New York City and Chicago

THE annual fall meeting of the American Electrochemical Society had originally been planned for Princeton, Sept. 30 to Oct. 2, but owing to the commandeering of the University of Princeton by the Government, the meeting place was changed to Atlantic City. An unusually attractive technical program and the very favorable weather brought the unexpected total attendance to 115. The seriousness of the times was reflected in the program; there were no social functions whatsoever and the main feature was the all-day symposium on "Electrochemistry After the War." The

The occluded element, hydrogen or oxygen, is less closely combined with the solvent metal than is the solute in a solid solution. The form of hydrogen that causes the platinum wire to expand is very likely different from the form that produces the commonly observed increase of resistance during occlusion, but is possibly identical with the hydrogen that causes a diminution of the resistivity of the metal.

In the discussion of Professor Smith's paper, Dr. J. W. RICHARDS referred to the decrease in resistivity of alloys treated in hydrogen, in particular ferrocerium.



AMERICAN ELECTROCHEMICAL SOCIETY AT ATLANTIC CITY, SEPTEMBER 30, 1918

meeting was opened by President F. J. Tone in the Belvedere room of the Hotel Traymore.

The first paper on the program was presented by Professor DONALD P. SMITH of Princeton University on

### PROCESSES WITHIN THE ELECTRODE WHICH ACCOMPANY THE DISCHARGE OF HYDROGEN AND OXYGEN

The effect of the occlusion of hydrogen and oxygen by various metals was investigated. Small wires of palladium, platinum, tantalum and iron were used as anodes and cathodes and changes in electrical resistance and length of wire due to the occlusion of gases were determined. It is well known that when palladium occludes hydrogen, either electrolytically or from exposure to the gas, a marked increase in the electrical resistance of the metal results. Smith found, however, that when a fine platinum wire was made cathode at a current density of about 0.3 amperes per square decimeter, the ohmic resistance of the platinum wire decreased during occlusion of hydrogen until it reached a steady value. Similar results were obtained with oxygen in the case of palladium wires. In general it may be said that both hydrogen and oxygen first enter an electrode in a transitional condition in which they possess a conductance of their own. It appears that this conducting form of hydrogen is not intimately united to the solvent metal, but exists in a state which resembles rather one of mere mechanical enclosure, and this view is supported by the fact that the wires stretch during occlusion. Upon removal of the occluded gas the wires assume their original length and resistivity.

Mr. W. R. MOTT of the National Carbon Company, pointed out that it had always been difficult to place hydrogen in the periodic system and that perhaps the monatomic modification would fit in well in the metal group. In answer to a query by Major FRARY, Professor Smith pointed out that the elongation of the platinum and palladium wires during occlusion does not exceed the elastic limit.

### THE SIGN OF THE POTENTIAL

Professor O. P. WATTS of Wisconsin University next presented a paper on the Sign of the Potential. This question has been the source of long discussions at previous meetings of the Society and the present paper is what might be called the "minority report." Professor Watts argues in favor of the plus sign for the potential of zinc. His strongest argument is that according to present conceptions, the electric current is a flow of negative electrons and these electrons can flow only to material of relatively higher or more positive potential. Messrs. FRARY, FITZGERALD, MOTT, FINK and RICHARDS discussed the paper. The majority favored the adoption of the minus sign by the Society and to have all papers published in the Transactions adhere to the adopted standard.

### SEPARATION OF RADIUM EMANATION AND ITS DETERMINATION ELECTROSCOPICALLY

Mr. J. E. UNDERWOOD of the Bureau of Mines, Golden, Colorado and Professor HERMAN SCHLUNDT of the University of Missouri described an apparatus and method for determining radium in various ores and concen-

trates. The apparatus has proved very serviceable for determining the radium content of monazite sand and the concentrates obtained therefrom in the extraction of mesothorium from this ore.

#### THE EFFECT OF RADIUM EMANATION ON THE HYDROGEN-OXYGEN EQUILIBRIUM

Dr. S. C. LIND, radio chemist of the Bureau of Mines, reported upon an experimental investigation on the Heterogeneous Equilibrium of Hydrogen and Oxygen Mixed with Radium Emanation. Dr. Lind found "that an electrolytic mixture of hydrogen and oxygen gases, when mixed with radium emanation in a spherical bulb of 2 cm. diameter, will combine at ordinary temperature to an extent of nearly 99 per cent of completion, before equilibrium is reached. Through comparison of the known relative efficiencies of alpha rays in bringing about (1) the combination of hydrogen and oxygen, and (2) the decomposition of water, equilibrium would be expected at about 50 per cent of complete combination, if the  $H_2O$  vapor were condensed evenly over the whole inner surface of the reaction bulb. Localized condensation of water will not affect its rate of decomposition until the depth of the layer exceeds the range of the alpha ray in water. This takes place when its area is about  $1/35$  of the total area. Further localization results in diminishing the opportunity for the decomposition of water and a consequent shifting of the equilibrium toward recombination. The limit would be reached with all the water condensed in a single semi-spherical drop. The equilibrium is then calculated to be 95.5 per cent of total combination. When the quantity of water in the system is large, very high gaseous pressures would be produced before equilibrium results. A theory is advanced that the high pressure produced when an imperfectly dried radium chloride, or bromide, is sealed in a small tube, is due to hydrogen alone, not to a mixture of hydrogen and oxygen, the oxygen having been bound chemically as a basic salt."

#### MILITARY APPLICATIONS OF ELECTROPLATING

Dr. WILLIAM BLUM of the Bureau of Standards gave a very interesting outline of the Bureau's suggested Classification of Protective Coatings on Metal Parts of Military Supplies. For steel or brass which requires protection only during storage and transportation a protective coating of grease, slushing oil or similar compound is to be used; for steel or brass for indoor use or for mild exposure, any protective coating that will produce the desired color appearance and resistance to abrasion. This coating may be applied electrolytically, as for example nickel-plate, or chemically as by the copper nitrate process; or mechanically, as, for example, enamel. For steel subject to moderate outdoor exposure, zinc plating should be given preference. For steel exposed to severe outdoor conditions zinc coatings only should be employed. For steel requiring special protection against corrosive liquids, for example, gas shells, lead plating is to be used. For metal to be used in contact with food, nickel or silver plating, tinning or silicate enamels are prescribed.

#### IRON THAT CAN BE WHITTLED WITH A JACK KNIFE

Mr. F. C. KELLEY of the General Electric Company annealed samples of American ingot iron in an atmos-

phere of hydrogen for three hours at 900 to 950 deg. C. Upon testing the hardness of same he found that it was only 20 points higher than dead-soft copper on the Brinell scale. If annealed copper and annealed iron are each worked to produce a one-third reduction in thickness, the hardness of the copper increases over 100 per cent, while iron increases only about 60 per cent. In the discussion of Mr. Kelley's experiments, COLIN G. FINK pointed out that the hydrogen anneal of the ferronickel core of his leading-in wire was an important step in the process of manufacture of the wire, since the hardness of the core and copper shell must be about the same to insure a constant proportion of copper to core to the very last die in the drawing process.

#### NITRIC ACID BY THE ELECTRIC ARC PROCESSES

Mr. E. KILBURN SCOTT of Manchester, England, gave an interesting exposition of the various arc processes for the fixation of atmospheric nitrogen. He described at length the operation of his own furnace and pointed out the various advantages over other types. The paper was discussed by Messrs. ATWATER and LANDIS. The conical arc flame of the Kilburn Scott furnace is its most characteristic feature. The paper will be reviewed in extended form in a later issue.

#### HIGH-TEMPERATURE RESEARCH

Mr. W. R. MOTT of the National Carbon Company reported upon experiments he had carried out in the carbon arc to determine the Relative Volatilities of Refractory Materials. A vast number of experiments were made and many interesting and important results obtained. We give here a few of the most striking conclusions:

"For materials boiling above iron saturated with carbon (3500° C.), a series of boiling points were estimated on a triple basis of reference (1) to the curves with iron for equal (atomic) amounts of material, (2) fractional distillation and (3) position of deposition at negative crater. The boiling points of this series are as follows:

	Deg. C.
Iron Saturated with Carbon.....	3500
Silica.....	3500
Palladium.....	3600
Carbon.....	3700
Aluminum oxide.....	3700
Chromium carbide.....	3800
Vanadium carbide.....	3900
Rhodium.....	4000
Platinum.....	4050
Uranium carbide.....	4100
Ruthenium.....	4150
Lanthanum oxide.....	4200
Titanium carbide.....	4300
Yttrium oxide.....	4300
Columbium carbide.....	4300
Zirconium oxide.....	4300
Thorium oxide.....	4400
Iridium oxide.....	4400
Osmium.....	4450
Molybdenum carbide.....	4500
Yttrium carbide.....	4600
Thorium carbide.....	5100
Tantalum (carbide?).....	5500
Tungsten (carbide?).....	6000

#### DISCHARGE CHARACTERISTICS OF A DRY CELL

Mr. C. A. GILLINGHAM of the National Carbon Company contributed a paper on discharge characteristics of a certain make of dry cell. Tests were made on the well known No. 6 dry cell (2.5 x 6 in.) by discharging to given end-point voltages (1) through constant resistances, (2) at constant current through varying re-



sistances, and (3) through Mazda lamps. The results were illustrated by numerous charts and tables.

#### SOCIETY INVESTS IN LIBERTY BONDS

Following Mr. Gallingham's paper the Directors' meeting was held at which it was unanimously voted to invest \$2000 of the Society's funds in the Fourth Liberty Bonds. This brings the Society's total investment in Liberty Bonds to \$8000. Mr. C. G. Schluederberg, chairman of the Membership Committee, reported 1920 members on the Society's roster. The Board decided to hold the spring meeting at New York City and the 1919 fall meeting at Chicago in conjunction with the Fifth National Exposition of Chemical Industries.

The evening session, Sept. 30, was devoted to moving picture demonstration of the Fixation of Atmospheric Nitrogen at Niagara Falls, Power Development and Electrochemical Industries of the Shawinigan Water & Power Company and the Triplex Steel Process at South Chicago. The pictures were exceptionally clear and brought forth much favorable comment. At the South Chicago plant there will be ten 25-ton electric furnaces, forming the third step in the triplex process. The capacity, upon completion, will be 50,000 tons of triplex steel per month. The cost is about that of present open-hearth steel, according to Professor Richards.

#### SYMPOSIUM ON ELECTROCHEMISTRY AFTER THE WAR

President Tone had arranged for an all-day symposium on Tuesday. This proved a great success; many of the papers were of exceptional merit and the discussions had to be frequently curtailed on account of pressure of time. In his introductory remarks, Mr. Tone referred to the remarkable progress that electrochemistry has experienced within the last few years and emphasized that it was not too early to consider seriously what is to become of the various electrochemical industries after the War.

#### THE FUTURE OF ELECTROLYTIC CHLORINE

Mr. A. H. HOOKER of Niagara Falls reviewed the progress of the chlorine and alkali industry within the last generation and commented at length upon the present world-wide importance of chlorine gas and its numerous compounds: Chlorine for phosgene, for chlorpicrin, for mustard gas, for bleach, chlorine as a cloud gas and for smoke screens, chlorine as a disinfectant and sterilizer, chlorine for chlorbenzol explosives, picric acid and parazol, for chloroform for aeroplane dope and for fire extinguishers. Likewise, England, France, Italy and Japan, to say nothing of Germany, have all materially increased their chlorine output during the War. There will be a large surplus of chlorine after the War at the present rate of production and what is really needed are new uses against which chlorine can be charged at a fair operating price. "Our research departments and universities should give every encouragement to a larger development of our permanent chlorine industry, since the maintenance of these chlorine-producing plants with a constant market is as important to the Government as the maintenance of reserve plants for the manufacture of sulphuric acid, the fixation of nitrogen or any other basic munitions."

#### COMMERCIAL USES OF CHLORINE

Dr. V. R. KOKATNUR, of the Niagara Alkali Company, was the second speaker in the symposium. He enu-

merated and described in detail the present and most probable future commercial uses of chlorine. His paper was very highly appreciated and conceded to be a most valuable compendium. A full publication of Dr. Kokatnur's paper will be made in a later issue. The success of the electrolytic alkali industry depends not so much upon the profits obtained from caustic as upon those from chlorine. Hence chlorine is to be considered the primary product.

#### THE WAR AND THE NITROGEN INDUSTRY

Dr. W. S. LANDIS, of the American Cyanamid Company, presented the after-the-war possibilities of the nitrogen-fixation industries. The commercial production of air nitrates is but ten years old. In 1908 the world's production of nitrogen in the form of Chilean nitrate and of sulphate of ammonia was equivalent to only 503,000 short tons of nitrogen. In 1914, at the outbreak of the European War, the producing rate of the world in short tons of chemical nitrogen was as follows: nitrate of soda, 425,000; sulphate of ammonia, 285,000; arc process products, 11,000; cyanamid products, 31,000; synthetic ammonia and miscellaneous, 12,000; total: 764,000 tons. The estimated total for 1919 is 1,341,000 tons of which cyanamid products contribute 360,000 tons. The total production of nitrogen in the United States alone in 1919 is estimated at 509,000 tons, or 38 per cent of the world's output. The United States producing rate in the early part of 1919 will therefore be approximately three times that at the outbreak of the War. At the close of the War our consumption will probably be less than 50 per cent of the production. To take care of the excess nitrogen products, the fertilizer industry offers the most hopeful field of investigation. The Cyanamid company has appreciated the situation and has developed a new, highly concentrated fertilizer containing some 65 per cent of plant food, compared to 12 per cent and 20 per cent, the former standards. The cost in handling and freight will therefore be greatly reduced and the narrow strip of fertilizer-consuming farms along our coast, will be extended many miles inland. When fertilizer can be profitably put into the Middle West the consumption will be enormous. It would take the stimulating effect of several wars to build sufficient fixation plants to over-produce in such a market.

In the discussion of Dr. Landis' paper, Mr. C. G. ATWATER suggested that hereafter the modified Haber process be referred to as the "General Chemical Company's Synthetic Ammonia Process." The introduction of concentrated fertilizers which could be cheaply transported to our Central and Middle-West farms deserves every bit of encouragement. Mr. E. KILBURN SCOTT estimated the world's total arc processes for nitrogen fixation at 635,000 horsepower, and on the basis of 60 to 80 grams per kilowatt-hour an equivalent of 50,000 tons of arc-process nitrogen for 1919, and not 15,000 as estimated by Dr. Landis.

#### THE ELECTRIC FURNACE AFTER THE WAR

Mr. F. A. J. FITZGERALD, of Niagara Falls, talked on the electric furnace after the War. Some of the electric furnaces will undoubtedly go out of business. But many of the types will survive the strain of the reconstruction period. The induction-type furnace did not

develop as was expected. The advantage of dispensing with electrodes cannot be overlooked. Although the induction furnace is at present contending with lining and design troubles it seems most reasonable to expect that some modification of the Hering furnace will win out eventually. In general, the electric furnace situation after the war will be very largely dependent upon water-power development. Government ownership of water power is the most serious menace to the electric-furnace industry. It seems that the hour is rapidly approaching when it must be decided whether "the people exist for the state, or the state exists for the people."

In the discussion, Mr. ROBERT TURNBULL, of Welland, Ontario, agreed with Mr. Fitzgerald that water powers ought not to be in the hands of the government. Plants can be ordered shut down at any time and there is no redress. Mr. C. H. VOM BAUR, electric furnace engineer, of New York, maintained that as far as the electric steel industry was concerned, the future was well assured. Not only on account of the high quality of the electric steel as compared with ordinary steel, but also as a matter of economy, the electric furnace will survive and prosper. Many plants will introduce the duplex process, others will use the electric furnace for keeping ferromanganese molten and still others will maintain the electric furnace for melting scrap. At  $\frac{1}{2}$  cent per kilowatt-hour it is cheaper to melt scrap in an electric furnace than in any other. Mr. C. G. ATWATER brought up the question of power rates. Mr. P. J. KRUESI, of Chattanooga, Tenn., inquired as to the furnace patent situation after the War and hinted that difficulties might arise. Mr. E. KILBURN SCOTT cited the experience of England in municipal ownership of power plants. The outcome was most unfortunate. The biggest unit in England to-day is 15,000 kw. whereas in the States units of 60,000 kw. were not uncommon. Mr. HENRY E. RANDALL, lately with the Shawinigan Water and Power Company, discussed power rates and mentioned that the consumption of electric power in Ontario was 2.5 times greater per capita than in any other community. By cutting the rates in half the income from power users increased from \$700,000 up to \$840,000, whereas the returns on lighting dropped from \$300,000 down to \$250,000. However, the total income increased by \$90,000.

#### THE FUTURE OF ELECTRIC STEEL

Dr. JOHN A. MATHEWS, President and General Manager of the Holcomb Steel Company, contributed a paper on the Future of Electric Steel. "We are in our thirteenth year in the manufacture of electric steel. In automobile and airplane construction, and in many other ways, electric steel has given a splendid account of itself. Electric steel may well be called 'super steel.' It has had the indirect effect of stimulating better production on the part of open-hearth and Bessemer steel makers, and thus it may be considered as a beneficial acquisition to the entire steel industry. Easily oxidizing metals, like vanadium, chromium and manganese are readily handled in the electric furnace, and hence less of them need be had to give a final minimum content in the steel. Less of the oxides of these metals will be produced in the steel and therefore less of these oxides need be removed. Sulphur and phosphorus can be readily eliminated. With the electric furnace, alloy steels are made in the furnace itself rather than in the ladle, and

in this way there is better opportunity for increasing the solution, diffusion and homogeneity in the product. The field for electric steel in the future is a very promising one and when its merits are fully recognized new additional uses for it will be found."

Dr. MATHEWS' paper was discussed by Messrs. RICHARDS, EMERSON, SCHLUEDERBERG, DARLINGTON, MILLER, SCOTT and TURNBULL. Dr. RICHARDS referred to the manufacture of armor plate. Fifty per cent of the alloy goes back to the furnace and practically all of the chromium is lost on remelting. If electric furnaces could be introduced in the manufacture of armor plate a great saving would be brought about since practically all the chromium would be retained by the alloy. All attempts to convince the authorities of the advantages of the electric method have been of no avail. Electric steel production often requires less skilled labor than does the open-hearth or crucible process. Mr. DWIGHT D. MILLER prophesied that the electric annealing furnace would surely continue to prosper after the War on account of its numerous advantages and economies over older methods: electric annealing is automatic and absolutely reliable. Conditions of temperature and time can be most closely controlled and readily duplicated. For example, in the heat-treatment of anchor chain, all links receives similar treatment. Mr. Miller also believed that electric brass-melting had come to stay, as it is a cheaper and better process. Mr. KILBURN SCOTT mentioned that the electric furnace had been the salvation of the aeroplane industry in England. Furthermore, electric furnace smelting of scrap right outside of London had saved useless freight trips to and from Sheffield.

#### ELECTRIC PIG IRON AFTER THE WAR

Mr. ROBERT TURNBULL, of Welland, Ontario, gave a highly interesting presentation on Electric Pig Iron After the War. This industry is still in its infancy. A year ago the total output of Canada was only 900 tons of electric pig per month. To-day this output in Canada has attained over 2500 tons, and by the latter part of November the production will be between 4000 and 4500 tons per month. The consumption of electrodes is about 21 pounds per gross ton of iron. The power consumption aggregates a little over 500 kw.-hr. per gross ton. The average analysis of 25 consecutive heats is as follows: Si, 1.16 per cent; S, 0.014; P, 0.020; Mn, 0.70; and C, 3.19. The desired silicon is 1.00 to 1.25 per cent. At present this low-phosphorus pig iron is made from scrap shell turnings. After the War this supply of scrap will cease. However, similar scrap will undoubtedly be available, since it is very probable that the open-hearth will discontinue the use of turnings as a matter of economy and expediency as soon as it can obtain its supply in heavy-melting scrap. If, however, the quantity of turnings available is insufficient to meet the demands of the electric pig industry, it is probable that the present furnaces would be used for smelting iron ore. About 1400 kw.-hr. is required to produce one gross ton of pig iron from a mixture of 50 per cent ore and 50 per cent turnings. The quality of electric pig is superior to that of ordinary pig and this in itself will very likely insure a steady demand for electric pig iron by high grade steel manufacturers after the War.



## THE POWER SITUATION AFTER THE WAR

Mr. C. A. WINDER, of the General Electric Company, spoke at length on that most vital of all questions, The Power Situation After the War. We have too long looked upon power production as a simple problem, an economic factor that would gyrate nimbly to the tune of "supply and demand." No definite action has been obtained from Washington simply because no comprehensive demand has been made upon the legislative bodies there. Water turbines have an efficiency of approximately 90 per cent compared with 8 per cent of the reciprocating engine, 17 per cent of the gas and oil engines and 21 per cent of the steam turbine. The super-steam-station idea, locating power plants of a half million horsepower at the coal mines, is as "fanciful and extravagant as a caliph's dream." A half million horsepower plant would require 55,000 cubic feet of water per second or considerably more than the entire Ohio river during its normal period. Water-power is the only economic power and "there is no reason why water power industry should not develop quickly to a size and importance far beyond the fondest dreams of the present day pioneer."

Mr. HENRY E. RANDALL in discussion pointed out that if all the water power in the United States were developed it would not take care of the present day demand. A large consumer of electric power is the storage battery and a battery of about half the weight of the present would find a very big market. The use of peak power is rapidly increasing in Canada and has resulted in a much higher general load factor. Dr. RICHARDS thought that super-steam stations ought not be discouraged on account of the question of cooling water supply. Although the water near mines is acid, acid-proof condensers could be used. Mr. KILBURN SCOTT said that in England it would be considered best practice to locate the super-steam stations at the water-side and to carry the coal in pipe lines to the stations. Mr. SCHLUEDERBERG, of the Westinghouse Company, referred to the large steam plants being built at coal mines in Pennsylvania. Mr. Winder added that if the government would act favorably toward water-power development, private interest would obtain capital for such developments easier.

## SURPLUS ELECTRIC POWER AFTER THE WAR

Dr. JOHN W. BECKMAN, of San Francisco, suggested in his paper two outlets for surplus electric power after the war. "Two industries, both of them basic and both of them producing products essential to mankind, appear as suitable life savers to the electric developments after the War." One of them is the iron and steel industry and the other is the fertilizer industry. A very important electro-metallurgical development awaiting a successful solution is the direct manufacture of steel from iron ore. We have already reached forward toward this goal; in the electric shaft-furnace pig iron is now produced, known as steel pig iron. The next step will be the finished steel. The other industry which would serve to consume power after the War is the fertilizer industry. Two of the important ingredients in a fertilizer are nitrogen and phosphorus. The nitrogen-fixation industry will continue, particularly if encouraged by the Government. It is an industry essential

in times of peace as well as in war. The phosphorus in our phosphate rock, distributed through many of our states, can be made completely water-soluble by electrical methods, whereas by the old sulphuric acid method, only a small per cent of this phosphorus is rendered water-soluble.

Discussing Dr. Beckman's paper, Dr. LANDIS, of the Cyanamid company, was of the belief that eventually there would be an international committee to guide and control the development of industries. The application of fertilizers might well be regulated or ordered by the governments. The same applies to the power developments. Everything points toward a government control of industries. Probably the railroads, telephones and other utilities will never go back to the old system after the War. Mr. L. E. SAUNDERS, of the Norton Company, called attention to the new interconnecting of power plants at Niagara Falls resulting eventually in much lower rates. Mr. ACHESON SMITH, of Niagara Falls, pointed out that the fertilizer industry was of the elastic type. When food prices are high, farmers have large incomes and gladly buy fertilizers; when food prices are low farmers will be forced to buy fertilizers.

THE GOVERNMENT AND THE TECHNICAL MAN  
AFTER THE WAR

Dr. F. A. LIDBURY, in his usual highly entertaining style, submitted his reflections on the government and the technical man after the War. It appears most probable that a number of the scientific boards and committees appointed during the War will continue after peace is signed. Furthermore, the present close working of men of pure science with those who have specialized in applied industry and engineering has proved so vastly beneficial to all parties concerned that "one may feel quite certain in hazarding the conviction that the two fields will never fall so far apart as before, and that industry will be the gainer to the extent that it permanently receives the originality of view and boldness of conception of the pure scientist."

Mr. H. B. COHO, of the United Lead Company, in discussing Dr. Lidbury's paper emphasized that the underlying, fundamental question for us to answer is: "Are we as technical men willing to take on the responsibility of government? Are we ready to shoulder the duties of a governmental office?"

Mr. L. E. SAUNDERS offered the following two resolutions: (1) That the American Electrochemical Society is in full accord with the policies of the United States Shipping Board and will gladly cooperate in every way. (2) That the Public Relations Committee of the Society investigate the pros and cons of government ownership of water power.

## RESEARCH AFTER THE WAR

Colonel BANCROFT received a well deserved ovation as he arose to present his views on research after the War. He heads the Electrochemical Committee of the National Research Council. "Remarkable changes have been brought about by the War. This applies to all branches of chemistry. In organic chemistry the whole situation has been changed: we have learned to consider yields. The application of physical-chemical methods to organic chemistry offers great possibilities.

Some of the poisons recently developed, such as the arsenical and prussic acid compounds, might become valuable insecticides. New organic gases that are now used to kill men might, after the war, be used to kill bugs. For many years after Sabatier's research on catalytic agents very little progress was made along these lines in organic chemistry. During the last few years, however, various catalytic agents have been used for making war gases and other compounds. We are just beginning to realize the vast possibilities. The new charcoal catalyst is better than any we made before. We are bound to find extended uses for it. In the production of ammonia a number of catalysts have been found which will surely be useful after the War. A completely new field of scientific research is bound to open up. How is this research going to be carried out? The National Research Council is encouraging the scheme whereby each industry will have its research laboratory, as for instance that of the American Cannery Association. It will also be important that the universities have research laboratories where the scientific basis of our industries could be investigated."

In the discussion, Dr. LANDIS suggested that handbooks include in the description of processes the yields of the products obtained.

#### COÖPERATIVE RESEARCH LABORATORIES

Dr. C. E. K. MEES, of the Eastman Kodak Company, spoke at length on coöperative research laboratories, their advantages and limitations. He pointed out that Great Britain had already inaugurated the scheme of establishing coöperative research laboratories and that results so far were very encouraging. The English Government subscribes one-half toward the cost and maintenance and the other half is covered by individual subscription from each member of the industry. These laboratories are very often operated in connection with the universities. There are five distinct types of problems that can be covered by a research laboratory: (1) fundamental research. (2) raw materials; new sources; new methods of working up. (3) products. (4) processes. (5) applications. Research of the types 1, 2 and 5 interests all industries. They are external to the works. However, numbers 3 and 4 are internal and are not suitable for coöperative research; they involve secret, competitive methods. The British Government therefore assumed that everybody would be interested in fundamental research when inaugurating the system. At the Rochester laboratory of the Eastman Kodak Company about \$30,000 a year is expended on fundamental research. "In one case we worked for five years before we found out what we were looking for!" But the new by-products found and developed during this time made the pure research a paying thing. There is also a good deal of advertising value in having a "tame research man" go to various society meetings and talk on the laboratory's pure research. As a result of his high-toned talk you will get orders. A research laboratory in a small concern can often make more money than a similar laboratory of a large corporation. In the latter there is too much red tape, whereas the small laboratory can go right ahead and make the new article and sell it to the public. What this country needs are National Research Laboratories, for example a National Alloys Research Laboratory to which all inter-

ested industries would subscribe. There are very few industries not interested in alloys. Similarly, let us have a Fuel Research Laboratory, a Metal-Cutting Research Laboratory—about a dozen national research laboratories of this type.

In discussing Dr. Mees' remarks, Mr. SCHLUEDERBERG suggested that some scheme be advanced for the coördination and coöperation of the various research laboratories now operating in this country. Thus much duplication of effort could be avoided and no doubt better and more rapid progress in research made. Dr. FINK referred to the deplorable condition of our patent laws and said that much of the success of the research laboratories depends upon proper protection and recognition of original products and processes. Dr. R. E. ZIMMERMANN, of the Research Laboratory of the American Sheet and Tin Plate Company, discussed the value and importance of research on the standardization of products. Mr. MOTT pointed out the dire need in this country of handbooks covering the various industries, handbooks such as are found in Germany. Dr. RICHARDS suggested that it would be well worth while studying the history of the Swedish Iron Masters' association in connection with establishing coöperative research laboratories in this country. Dr. M. G. WEBER called attention to the fact that very often new and valuable processes were not made public properly. He favored the appointment of a committee whose duty it would be to bring to the attention of the industries and its members the importance of a new process or product. Mr. C. P. MADSEN commented favorably upon the Patent Approval Association that is now working in conjunction with the National Research Council. Mr. KILBURN SCOTT announced that England was setting up a large research laboratory that was practically a duplicate of the Mellon Institute at Pittsburgh. What is needed in England and in fact in all countries is a committee that would look after the interests of "the poor inventor." In closing the discussion, Dr. MEES conceded that the patent question is a very important one and that some years ago he had written a paper outlining a Utopian Patent System—but being afraid of his lawyer friends, he never published it.

#### TARIFF PROBLEMS IN THE ELECTROCHEMICAL INDUSTRIES

Dr. GRINNELL JONES, chemist of the United States Tariff Commission, presented a paper on the tariff problems in the electrochemical industries. The Tariff Commission is trying to gather information which will be of value after the War. In the chlorine and caustic soda industry protective tariff legislation, 25 years ago, helped the development of the industry. Chemically we get the two products in equivalent amounts, but commercially the demand for caustic exceeds that for chlorine. We have therefore had large imports of bleaching powder. Between 1909 and 1913, 40,000 tons of bleaching powder was imported annually. In 1909, 58,000 tons was produced in the United States and in 1913, 155,000 tons. Our imports of bleaching powder in 1916 dropped to 16,000 tons, in 1917 to 33 tons and in 1918 to 2 tons. Our exports in 1918 will probably total 6500 tons bleaching powder; to this must be added the chlorine in form of poison gases. In 1914 we exported 48,663 tons of electrolytic soda and in 1917, 126,570 tons. What are we going to do with the excess chlorine after



the War? Not much help is to be expected from the dye industry since this consumes only about 2 per cent of the output. The carbon tetrachloride industry consumes but one per cent of the output. Chlorine manufacturers and chlorine consumers must keep the Tariff Commission closely advised as to production, consumption and new outlets.

In the abrasive division of the tariff laws there is at present considerable discrepancy in the duties imposed on the various products and raw materials. Grindstones and hones are on the free list and no distinction made whether composed of natural or artificial abrasives. On the other hand emery stones are taxed. Better classification is needed. The demand for artificial abrasives is greater than the available water power. About two-thirds of the artificial abrasives are now imported from Canada. Shall we put a duty on Canadian abrasives? We are now producing large quantities of phosphorus. And what is to become of the potash industry after the War? As regards the nitrogen-fixation industry, is the Government going to levy a protective duty and protect itself? It is necessary to collect in advance information in order to draw up proper tariff legislation, and the coöperation of the men of the industries is absolutely essential.

Mr. L. E. SAUNDERS, of the Norton Company, did not fully agree with Dr. Jones' statements relative to the abrasive situation and maintained that the shortage of natural abrasives had been fully met by the manufacturers of the artificial products. There is at present even an overproduction of artificial abrasives.

In bringing the symposium to a close, President Tone expressed his and the Society's appreciation for the highly interesting papers contributed and hoped that the serious problems that had been brought before the Society would give rise to further debates and discussions and future meetings.

#### THE NORTHRUP HIGH-FREQUENCY FURNACE

The main part of the Tuesday evening session was devoted to the new Northrup furnace. Dr. E. F. NORTHRUP, of Princeton University, gave a highly interesting address describing in detail the construction, development and operation of his latest type of induction furnace. A preliminary announcement and description of the Northrup furnace appeared in the Aug. 1, 1918, number of this journal. The experiments were started about two years ago for the Ajax Metal Company, of Philadelphia. Mr. G. H. Clamer, vice-president of the company, deserves much credit and appreciation for his support of the enterprise and his broad vision. Dr. Northrup also paid a graceful compliment to his mother who had ever taught him to have high ideals. It was a high ideal that formed the original conception of the new high-frequency induction furnace: "Heat the charge or its container without heating anything else."

The resistance type of furnace could never realize this ideal. The best resistance wire will stand but 1282 deg. C. and a furnace built of this wire would with difficulty melt copper (1082 deg. C.). For example, when the heat of this resistance furnace has reached 1081 deg. there is a temperature gradient inwards of 201 deg. and outwards to the room of 1282 deg. If we were to try to melt an alloy, of melting point 1282 deg., the efficiency of the furnace would be zero. Therefore for

high efficiencies the heat must be generated within the container. The high-frequency induction furnace is the solution of the problem. In order to attain the very high frequencies required, Dr. Northrup developed a high-frequency oscillatory discharge gap: there are three Acheson graphite electrodes surrounded by an atmosphere of alcohol. Eventually with the further development of the Alexanderson high-frequency alternator this discharge gap will be dispensed with. It is planned to build alternators of 1000-kw. capacity, whereas the largest units at present are rated at 200-kw. and 2300 cycles. In the present small type Northrup furnace brass can be melted at the surprising rate of 45 pounds in 35 minutes. Nickel is readily fused. In the small furnace, equipped with the oscillatory discharge gap, the efficiencies are around 50 per cent whereas eventually with an Alexanderson alternator efficiencies of 90 to 93 per cent are more than probable. One of the proposed large-scale adaptations of the new furnace is for the retention of the heat in the steel ladle. In this case the ampere turns would be embedded in the refractory lining of the ladle. In conclusion Dr. Northrup referred briefly to his "focus inductor" furnace in which any temperature that a magnesia crucible will stand can be attained. Messrs. SCOTT, BRALEY, CUMMINS, BRADLEY, ROUSH and MOTT participated in the discussion.

#### THE NORTHRUP FURNACE IN OPERATION

Dr. Northrup's address of Tuesday evening was supplemented by a personal inspection of the furnace at the Pyroelectric Instrument Company's laboratory at Trenton. The members of the Society left the Traymore early Wednesday morning arriving at Trenton about eleven o'clock. Dr. Northrup demonstrated at his laboratory how easily nickel could be melted in the high-frequency furnace and in a second experiment, roller-bearing rings were brought up to the desired quenching temperature in a very few minutes. In the latter case no crucible was required: the energy was focused directly onto the rings. There were also demonstrations of the high-frequency arc and focus inductor. The visit to the Pyroelectric laboratory was one of the most enjoyable features of the meeting. It was generally conceded that the high-frequency furnace was the greatest advance in electric-furnace design since the days of Moissan.

#### Prices of Sulphuric and Nitric Acids

On Oct. 4, the War Industries Board modified the division made on September 26 in evaluating sulphuric acid, whereby 92 per cent  $H_2SO_4$ , instead of 66 deg. B. (93.19 per cent) shall be the division point. Acid below 92 per cent  $H_2SO_4$  shall be evaluated according to its equivalent of 60 deg. B. acid at the price of \$16.00 per ton; and acid above 92 per cent  $H_2SO_4$ , on its equivalent of 66 deg. B. at \$25.00 per ton. See CHEMICAL AND METALLURGICAL ENGINEERING, page 571, for first announcement.

On Oct. 3, the statement of 8½c. per lb. as the flat rate for 42 deg. B. nitric acid was further amplified to read 67.18 per cent. This makes the price of nitric acid 2.53c. per ton unit, which is \$170 per ton for 67.18 per cent acid. This price applies to mixed acid also, in which  $H_2SO_4$  shall be 0.268c. per ton unit.

## The Use of Micro-organisms in Chemical Industry

**Yeasts, Moulds and Bacteria Important Organic Chemicals Widely Used in Industry — Further Industrial Applications and Developments Await Research — Some of the Possibilities**

BY ERNEST G. GENOUD

**T**HE MICRO-ORGANISMS to which we refer are yeasts, moulds and bacteria. They are of the nature of plants, and, like their vegetable colleagues most of them require for their growth and development carbon, nitrogen, water, oxygen, phosphorus and calcium. Many of them, like other plants and unlike animals, can metabolize nitrogen in the form of simple soluble salts instead of complex proteid substances. Others, again, find their principal nutriment in proteins.

They are classified according to their external forms. In physical appearance but not in any biological sense we may say that yeasts resemble microscopic vines, moulds resemble moss, and bacteria, rods and spheres. Their functions are of almost infinite variety, and there is a vast deal about them that is not known.

In a chemical sense the most familiar of all are the yeasts, or more particularly the *saccharomyces*, which split fermentable sugars into ethyl alcohol and carbon dioxide. They secrete especially two enzymes of which one goes forth from the yeast cells and effects a transformation of some sugars from an unfermentable into a fermentable organization. This does not consist in splitting them into single carbon chains. Some monosaccharides are not fermentable while some di- and trisaccharides are. The second enzyme remains in the yeast cell, and as the solution of fermentable sugars enters the walls the desired reaction takes place.

### NITROGEN ESSENTIAL TO FERMENTATION BY YEAST

If a culture of yeast is introduced into a solution of pure sugar and pure water, the ensuing fermentation will be very incomplete, for the obvious reason that there is no nutriment present for the yeast, so that its growth and progress are halted. It must have soluble nitrogen salts or compounds, and in the fermentation for beer or alcohol from grain or starch this is found in asparagin and other amido acids which are present in all young sprouts and especially in the barley sprouts of the malt. The primary purpose of the malt, as is well known, is to provide the enzyme diastase to convert the starch to sugar. Certain moulds may take the place of malt in this process. Our readers may recall such a mould introduced by Dr. Takamine from Japan which was a culture, as we recall it, used in the production of sake from rice in that country. In France there is now a great industrial alcohol plant using potatoes for starch, and there a mould instead of barley malt is employed. When sugar is the initial material instead of starch, as in the case of grapes or molasses, no malt or diastatic agent is required in fermentation.

We shall not address ourselves to the main process of fermenting sugar to alcohol and  $\text{CO}_2$ , which is familiar to all chemists, but consider rather some of the by-products which are always present, and are found in

varying proportions. These are iso-butyl and amyl alcohol, glycerol, succinic acid, acetaldehyde, acetic acid and various esters. Just how iso-butyl alcohol is formed as a product of yeast fermentation is not known. We shall not consider the subject at length because butyl alcohol is produced in great quantities in one of the biological processes for making acetone, and again butyric acid is obtained direct from starch by a special bacillus, so that if an industrial demand for either the acid or the alcohol should arise it may be met in abundant quantity. Amyl alcohol on the other hand is called for with a loud cry, and fortunately it is known that its presence is due to the fermentation of proteid substances and not to that of sugar. It is sorely needed for the production of amyl acetate as a solvent for nitro-cellulose and, to a less extent, for synthetic fruit syrups and perfumes. And if it ever should become cheap enough, the industrial steps from amyl alcohol to isoprene and from isoprene to synthetic rubber are nearly in sight. There is, therefore, every reason for the incidence of research upon the problem of cheap production in large quantities of this once detested and injurious ingredient of potable liquors. When we get to know beans as well as Dr. Theodore B. Wagner and certain other chemists know corn, and even before that, it may become a profitable enterprise to study the fermentation of proteins to fusel oil along with the starch to ethyl alcohol. Since beets are grown with profit in the beet sugar industry it may be that beans will be grown with profit to produce ethyl alcohol together with large quantities of amyl alcohol. The subject is full of interest. In present day fermentation it sometimes happens that iso-butyl and amyl alcohols are found to the extent of  $\frac{1}{2}$  to 1 per cent in crude distilled spirits.

### GLYCEROL PRODUCED IN SMALL QUANTITIES

Glycerol seldom runs above one-third of one per cent of the fermented mush, and it has not been found economical to separate it thus far, notwithstanding the war's demands for glycerine for nitrating purposes. How it is produced is not known; that is, there is less known of it than there is of the production of amyl alcohol by fermentation. Whether under post-war conditions there will be any such demand for glycerine as there is at present is open to question. Whether also the road to biologically produced glycerine is too long to be undertaken in the face of the immediate demand is also a subject for discussion. Perhaps the matter is already in hand at American University. According to reports lately received the Germans have developed a yeast of which the cells contain as much as 40 per cent of fat in the dry substance instead of about 5 per cent which is the usual proportion. It is said that they have been cultivating this in quantity and removing the glycerine by saponification, but we do not guarantee the truth of this statement.

The more specific production of succinic acid and the innumerable esters are also subjects for research in less crowded hours, while the steps from ethyl alcohol to acetic acid are known and studied, and are in good hands.

At the present stage of the art it may be said that the development of excessive undesired by-products in the fermentation for ethyl alcohol is usually due to



infected yeast and occasionally to overmuch foaming of the beer and the consequent oxidation that ensues.

#### CONSTRUCTIVE AND DESTRUCTIVE METABOLISM OF YEAST

In the production of alcohol, whether for drink or industrial uses there is always a great excess of yeast grown, because of the rapidity with which the cells reproduce. Under favorable environment the plant thrives lustily and while the manufacturer is always careful of the comparatively small amount that goes into every fresh vat, he has a great quantity left over after every fermentation.

Here is waste, a serious waste, and one that should be avoided. Usually it is messy stuff and like most good things that we discard, it does not behave very well under such treatment. Being rich in protein it is a valuable food. Properly treated it is good cattle fodder, and still more carefully treated it is excellent human food, and is considerably used in England for this purpose. The preparation is interesting: In the building up of yeast cells, as we have already observed, the nitrogenous constituents may begin with very simple ammonium salts. In the metabolism of the plant these ascend in steps of increasing complexity to amido acids, peptones and albumoses to insoluble albumen. Now, if the yeast is washed free of all wort and mash and is left to stand wet or in pure water, it proceeds, having no nutriment, to consume itself by a process of auto-digestion, induced by the enzyme endo-tryptase. At the optimum temperature of about 40 deg. C. the insoluble albumen is broken up and the direct reverse of the metabolic process takes place. There occurs a breaking down, in consecutive order, of insoluble albumen to albumoses, peptones, amido acids and, finally, ammonia.

#### VEGETARIAN "BEEF EXTRACT"

This is not putrefaction, and unless the yeast is infected putrefaction will not take place. By halting the process at a point at which the peptones and amido acids predominate, and sterilizing at about 70 deg. C. to destroy the enzymes, the product remains stable. For convenience of transportation and use it is then concentrated and the result is a food which is fully equal to beef extract, containing up to 35 per cent of peptones and amido acids. If properly made it is very agreeable to the taste and is not to be distinguished from beef extract save by very astute analysis. It has reached an important industrial stage in England and the yeast product made in this manner is sold as vegetable extract under the trade name of Vegex. It enables the vegetarian to have his beef juice without the passing of the steer, but its consumption is by no means limited to vegetarians. The amido acids are excellent digestive stimulants.

For cattle feed the yeast is washed and dried. Being relatively rich in nitrogen, potash and phosphorus, it should also serve well as a fertilizer.

#### BACILLI PRODUCE ORGANIC ACIDS

The most widely known industrial use of moulds is in the production of cheese, to which we shall give but passing mention and proceed to consider bacteria which are divided into three classes, according to their external form. They are of almost endless variety.

They are the smallest forms of plant life, some being not over  $2\mu$  in length. The spirillum, on the other hand, which is also a variety of bacteria, grows up to the length of 12 to  $15\mu$ . The three principal types are the bacilli which are rods somewhat of the shape of minute Frankfurter sausages, the cocci which are spherical, and the spirilla which are corkscrew shaped.

The lactic acid bacillus has the function of converting almost any starch into sugar and the sugar into lactic acid, and it is impossible to isolate the sugars during the process. It is used by manufacturers of compressed yeast, who look for the greatest production of yeast rather than of alcohol, because it decomposes the complex albumen molecule and brings it down to amido acids, at which point the yeast is much more able to assimilate its nitrogen. If the demand for lactic acid should increase there should be no difficulty in meeting it.

There is also a butyric acid bacillus which attacks starch, sugar and lactic acid and produces the ill-smelling butyric acid. And in recent years bacteria have been discovered which produce acetone from carbohydrates, along with a greater quantity of butyl alcohol as a by-product.

The cocci and spirilla are more generally known from their pathogenic representatives, although there is no known rule or relation between the shape and size of a micro-organism and its function.

#### SOME FUTURE PROBLEMS

We have considered a few of the bodies known to be produced and it seems as though properly directed research might not only add to the sum of knowledge but enhance the national estate as well. Let us therefore engage the imagination a little and see what possibilities beckon us over the fire-fly swamps where the roads have not been laid out as yet. If we have yeast to make ethyl alcohol in quantity from sugar and starch and amyl alcohol inadequately from proteid substances, and a bacillus for butyl alcohol from starch, why should we not find or develop a culture for propyl alcohol, and more especially for the production of methyl alcohol? We separate cetyl alcohol,  $C_{18}H_{37}OH$ , from spermaceti, and melissyl alcohol  $C_{26}H_{53}OH$ , from beeswax. The higher alcohols are excellent waxes; why not try to find a micro-organism to make them in tubs? These are likely to be cheap processes if they are started right.

Again there is the fermentation of cellulose to methane and hydrogen. Here is an enormous field for study. Nature does it in marshes and in the earth, so why should we not wring the secret from her and get it under control? Even the gases formed within the body are due to the fermentation of cellulose and not to that of starch or proteins. Under proper conditions we could grow our own gas, making it fresh every day, and save coal. Imagine a great vat in a prosperous village, seething away, fermenting wood-waste, garbage, old newspapers, and rubbish of every sort, and delivering methane and hydrogen into a convenient gasometer. Observation thus far seems to indicate that the cellulose is hydrolyzed to sugar by means of an enzyme and that fermentation proceeds to  $CH_4$  and  $H_2$ , while the lower fatty acids arise as by-products.

Arthur D. Little, Inc.,  
Cambridge, Mass.

## Reinforced Concrete versus Salt, Brine and Sea-Water\*

An Account Citing Many Examples of Failures in Reinforced Concrete and Showing the Cause to Be Due to Electrolytic Corrosion of Reinforcements

By HENRY JERMAIN MAUDE CREIGHTON

ON ACCOUNT of the rapidity and cheapness of construction, at present attention is focused on the reinforced concrete ship. A large reinforced concrete ship has just been launched at a Pacific port in the United States, where others are in the process of construction; and it is believed that such ships will be built on a large scale. Although the durability of the reinforced concrete ship is still an undetermined factor, the claim is made that it would exceed the term of the war. In a large measure the durability of reinforced concrete ships will depend upon the action of the sea-water on the concrete and on the iron reinforcements.

During the past few years there has been considerable discussion regarding the durability of concrete, and there exists a certain amount of disagreement on the subject. There appeared in *Engineering News* of April 4, 1912, wherein is published a report of the American Society for Testing Materials' meeting, the following sentence: "The report of the waterproofing committee brought about some excited discussions, during which several persons affirmed their belief in the imperishability of concrete and protested against any hint of any other possibility." However, though "it is no doubt true that many diseases can be cured by a practitioner who strenuously denies their existence and thus encourages the patient to resist and overcome them, it can hardly be expected that defective concrete walls or disintegrating piers can be strengthened by 'absent treatment,' however vigorous be the denial of the injury or however prominent the denier." It is much better to look facts in the face and attempt to find a remedy.

### REACTION BETWEEN THE ALKALI SALTS AND THE CEMENT SILICATES

Sea-water, one of the agents which brings about the disintegration of concrete, attracted the attention of users of cement soon after it was first employed in marine construction. Although a great deal of non-reinforced concrete has withstood the action of the sea up to the present time, and will probably continue to do so, still some of it has failed. While the cause of this disintegration is not definitely known, Le Chatelier and others have pointed out<sup>1</sup> that it can probably be ascribed to a reaction between the magnesium sulphate of the sea-water and the lime of the cement (formed during setting) and the alumina of the aluminates of the cement, with the resulting formation of magnesium hydroxide and calcium sulpho-aluminate, which crystallizes with a large number of molecules of water. Notwithstanding that the other components of sea-water have usually been supposed to have but little effect on

concrete, attention has recently been called to the fact that both sodium chloride and magnesium chloride rapidly react with the silicates in concrete<sup>2</sup>.

In the laboratory it is possible to destroy, almost completely, small cylinders or other forms of concrete or cement mortar by the action of solutions of various salts. The "action of the salts in alkali water and sea-water on cement" has been the subject of a lengthy investigation by Bates, Phillips and Wig, of the U. S. Bureau of Standards, and their results have been published<sup>3</sup> under the foregoing title. This investigation was undertaken in consequence of disintegration of concrete, through the action of water containing magnesium and sodium sulphates, occurring in several integration projects in some of the Western States; and for the purpose of ascertaining the action of various single and mixed salt solutions on concrete and cement. The salt solutions were allowed to percolate through hollow cement cylinders closed at one end, and it was found that any cement mortar may be destroyed if a sufficient amount of salt accumulates and crystallizes out. It was further found that, in general, chloride solutions were more effective than sulphate solutions in removing lime from concrete, but that mixed chloride and sulphate solutions were more effective than solutions of single salts.

### CRACKS DUE TO INCREASE IN VOLUME UPON RUSTING OF THE REINFORCING BARS

Several years ago the writer constructed a number of concrete blocks 3 ft. x 1 ft. x 1 ft., in which were imbedded several iron rods, and exposed them to the weather. A small quantity of sodium chloride was mixed in with the concrete. Gradually these blocks developed cracks which widened and spread as time went on; and today some of them have fallen to pieces, leaving the reinforcing rods in a badly corroded condition, while the others are badly deteriorated and iron-stained.

A striking example of the deterioration of marine reinforced concrete is to be found in Young's "Million Dollar" Pier at Atlantic City, New Jersey. At the end of two years after its completion, some of the piles commenced to disintegrate owing to the corrosion of the reinforcements. The disintegration proceeded so rapidly and the structure became so weakened, that in the winter of 1912 a large portion of the pier was swept away by a storm.

At the Key West extension of the Florida East Coast Railway, one of the steel reinforced concrete viaducts was found to have undergone extensive deterioration within two years after its completion, and in conse-

\*Read before the Faraday Society, July 23, 1918.

<sup>1</sup>Le Chatelier, *Tonindustrie Zeitung* 33, 931. Chandlot Ciments et Chaux hydraulique, page 306. Michaelis, *Bul. de la Soc. d'Encourage de l'Industrie*, June, 1897.

<sup>2</sup>Chandlot (loc. cit.). Michaelis, *Bul. de la Soc. d'Encourage de l'Industrie*, 632, 1890. *Engineering Record*, July 20, 1910.

<sup>3</sup>Bureau of Standards, technical paper 12. *Journ. Franklin Institute* 175, 65.



quence, since 1909, all viaducts have been constructed without reinforcements, and with a cement low in magnesium and sulphuric acid and finely ground.

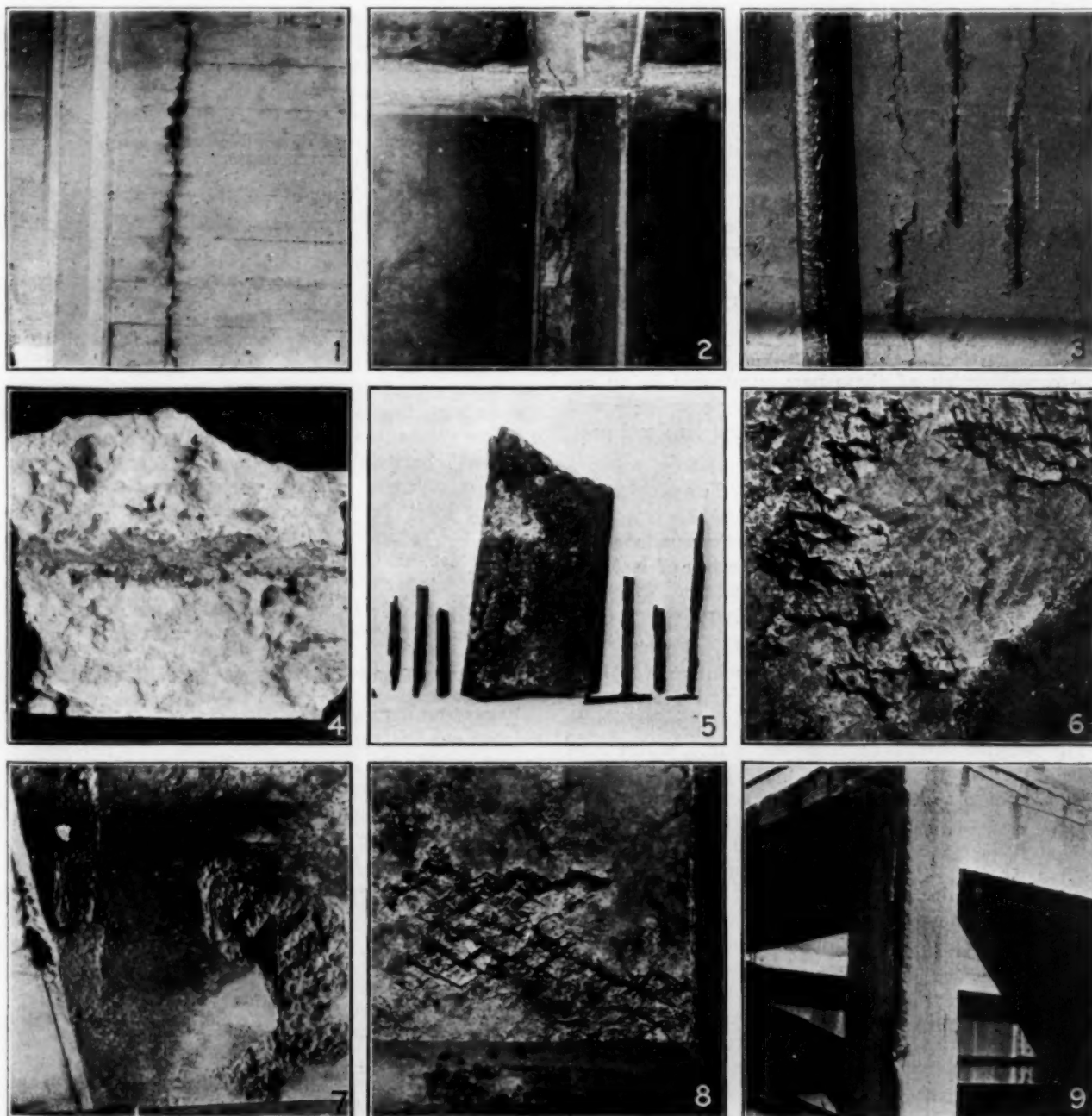
According to a recent report<sup>1</sup> by J. L. Harrison, District Engineer, Hoilo, the cracking of reinforced concrete structure is markedly prevalent in the Philippine Islands. A study of this trouble has demonstrated that not a single structure showing rusted steel has been free from salt, the percentage of which varies considerably. In view of this, engineers in the Philippines have been advised that not only is the use of salt water dangerous in concrete structures, but that beach sand and beach gravel should be employed only after having been thoroughly washed with fresh water.

<sup>1</sup>Bul. of Bureau of Public Works, Oct., 1916.

The foregoing, and many other similar pieces of evidence, indicate that salt, brine, and sea-water exert a deteriorating action on concrete.

The possible causes of the deterioration of ordinary concrete are bad cement, bad aggregate, bad proportions, bad mixing, external violence, wear and tear, and the action of saline solutions; while for reinforced concrete, in addition to the foregoing causes, there are corrosion of the reinforcements either directly or by electrolysis, and cracking due to monolithic character, or possibly to stresses between the concrete and the reinforcements.

As this paper deals chiefly with the corrosion of iron reinforcements of concrete due to the action of brine, the probable reactions which occur when this metal comes in contact with a salt solution will be discussed briefly.



ILLUSTRATIONS OF BREAKS IN REINFORCED CONCRETE CAUSED BY CORROSION

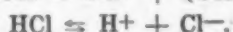
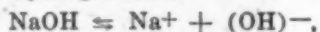
Fig. 1—Ceiling; 2—Beam; 3—Wall, embedding concrete falling away; 4 and 5—Corroded reinforcing bars; 6, 7 and 8—Metal lath corrosion; 9—Platform and pillar disintegrating

## CORROSION OF IRON DUE TO ELECTROLYSIS

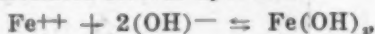
When a piece of iron is placed in distilled water, it becomes negatively charged, since its electrolytic solution pressure (which is equal to  $1.2 \times 10^4$  atmospheres) causes atoms of the metal to enter the water as positively charged ions, leaving an equivalent number of negative charges behind on the bar of metal. In spite of this large electrolytic solution pressure, only a vanishingly small quantity of the iron passes into the water in the form of ions, and consequently the metal bar receives but a correspondingly small negative charge. This is due to the fact that when a ferrous ion with its large positive charge ( $2 \times 96,500$  coulombs for every gram ion of the metal) leaves the bar of electrically neutral iron, the latter acquires a negative charge of corresponding magnitude; it therefore becomes more difficult for a second ferrous ion to enter the water, owing to the attraction between unlike charges of electricity; and it is still more difficult for a third ferrous ion to leave the metal, and so on. Consequently, very soon the negative charges upon the bar of metal become sufficient to prevent further ferrous ions entering the water, and equilibrium sets in; and, unless these negative charges are removed from the metal, no more iron can pass into the water. But suppose, now, that common salt be added to the water containing the bar of iron. On dissolving, this electrolyte largely dissociates into its ions, and it may be assumed that hydrolysis takes place, although to a very limited extent, in accordance with the equation—



The concentration of these new substances being extremely small, they dissociate practically completely, and give rise to negatively charged hydroxyl ions and positively charged hydrogen ions:



The hydroxyl ions then unite with the ferrous ions that have passed into the solution from the bar of metal to form undissociated ferrous hydroxide:



which gradually precipitates as an hydrated oxide. The presence of dissolved oxygen in the solution would, of course, gradually convert the oxide and ferrous hydroxide into the corresponding ferric compounds.

The negative charges upon the bar of iron, which were in equilibrium with the ferrous ions before the addition of the sodium chloride, now attract the positively charged hydrogen ions, the electrolytic solution pressure of hydrogen being much less ( $9.9 \times 10^{-4}$  atmospheres) than that of iron and very much less than that of sodium ( $>10^4$  atmospheres), and, in consequence, hydrogen ions move toward the negatively charged iron bar, touch it and become neutral gaseous hydrogen atoms. The negative charges upon the bar being thus diminished, more iron enters the solution in the form of ferrous ions, and the foregoing process occurs again, and so on. In this way the bar of iron gradually disappears and iron oxide and hydrated oxide accumulate.

The nascent hydrogen which is produced on the bar may be absorbed by the iron; it may be oxidized by the oxygen dissolved in the solution, or it may be liberated as a gas.

Some of the preceding steps have been demonstrated by the writer. In order to determine whether gaseous hydrogen is ever liberated under the foregoing conditions, a number of pieces of iron were immersed in dilute aqueous solutions of sodium chloride contained in glass tubes with a capillary top, and connected at the bottom with a small glass tube bent upward at right angles. Before being introduced into the glass tubes, the salt solution was boiled to remove the air, and afterward, before sealing off the tip of the capillary, a high vacuum was applied to the solution for some time. It was found that in all the tubes a greyish-green deposit slowly accumulated near the bottom, and at the end of several months a small quantity (0.1 to 0.2 cc.) of gas had formed in three of the tubes. This gas proved to be mostly hydrogen. In an investigation on the electrolytic decomposition of iron which is still in progress, it has been found that considerable quantities of cream-colored ferrous hydroxide may be produced under conditions analogous to the foregoing.

In addition to the corrosion of iron through the action of brine by the process just outlined, auto-electrolysis only occurs on account of the electrical potential differences which exist in commercial forms of iron due to the presence of segregated impurities. These differences, which are augmented by chlorides of the alkali metals, bring about a galvanic action that causes the iron to go into solution at certain points with the formation of oxide.

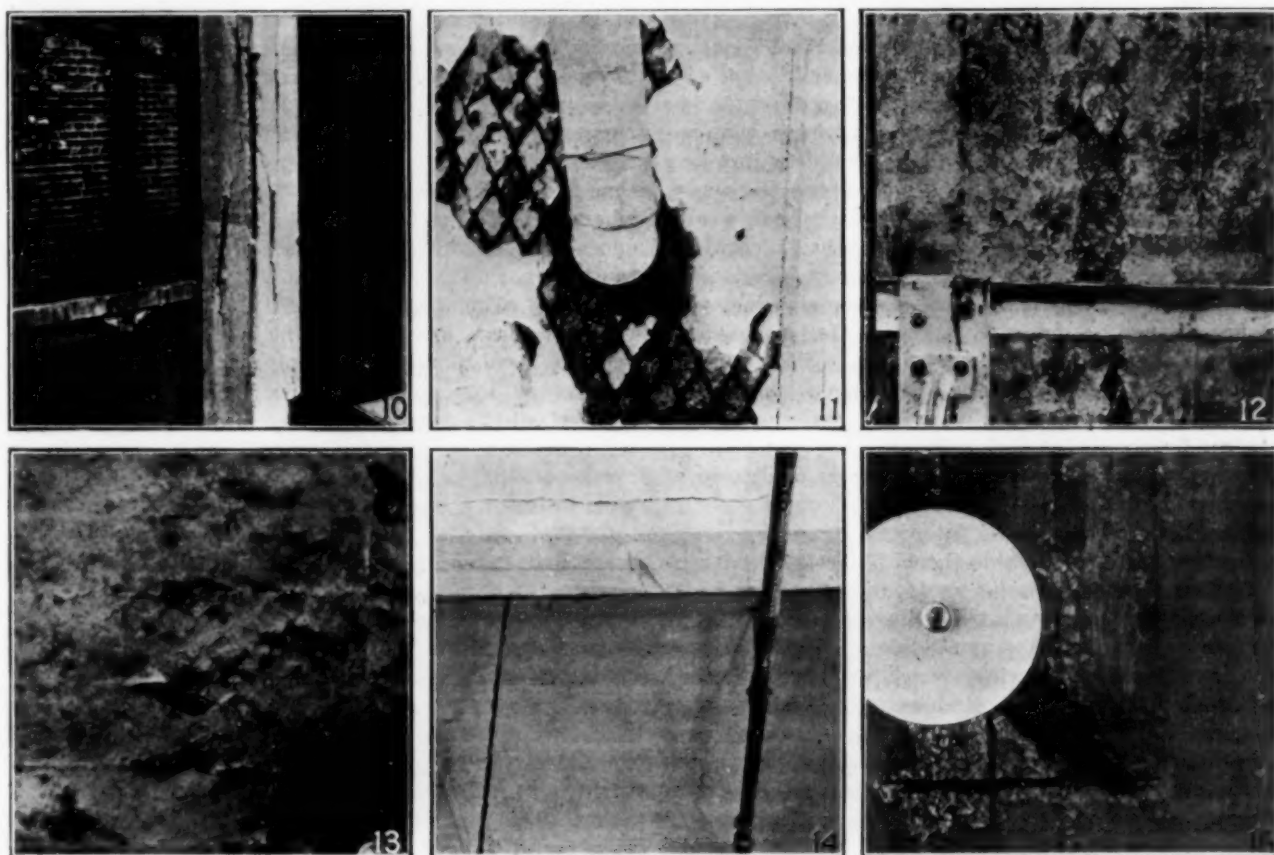
From what has been said, it should be clear that reinforced concrete which comes in contact with brine or sea-water will commence to deteriorate as soon as the brine comes in contact with the reinforcing rods; for, as both iron oxide and the hydrated oxide occupy a larger volume than the corresponding amount of iron, there will be developed an enormous expansive force, which is sufficient to crack the strongest concrete and force it away from the reinforcing rods. The more porous the concrete, the more rapidly will this disintegration set in. Indeed, the writer is familiar with cases of cylinder concrete structures, in contact with brine, which have shown signs of advance deterioration at the end of the year after their completion.

## WATER PROOFING PROCESSES NOT PERFECTED

Regarding the water-proofing of concrete, it should be pointed out that an impervious concrete is seldom obtained outside the laboratory. The average concrete is practically never waterproof. Although there are many substances on the market for rendering concrete waterproof, the majority of them are far from satisfactory. A number of such substances have been investigated by Brown<sup>1</sup>, who points out that all waterproofing materials will sooner or later hydrolyse, crack, or disintegrate. About a year ago the City of Philadelphia, upon the recommendation of the Franklin Institute, awarded the John Scott Legacy Medal to Max Ulrich Schoop, of Zürich, for his invention, the Schoop Metal Spraying Process. By means of this process various metals can be sprayed under high pressure upon any slightly roughened surface so as to form a smooth, adherent skin. After examination of the results produced by the Schoop process, the writer is of the opinion that by this means

<sup>1</sup>The Electrician, 69, 915 (1912).





ILLUSTRATIONS OF BREAKS IN REINFORCED CONCRETE CAUSED BY CORROSION

Fig. 10—Badly shattered pillar due to corrosion of reinforcements. Figs. 11 to 15—Illustrate cases similar to those previously shown

concrete might easily be rendered impervious to water or brine.

#### PAINTING THE REINFORCING RODS

It has often been suggested that the deterioration of reinforced concrete through electrolysis might be prevented by the use of protective paints upon the metal that is to be imbedded in the concrete. A few years ago, the protective action of a large number of paints was very thoroughly studied by Gardner\*, who points out that if the reinforcements are treated with suitable insulating and bonding paints before they are imbedded in the concrete, the causes which contribute to electrolysis will be guarded against and concrete structures will be rendered safe from deterioration through corrosion of the reinforcements. From the results of his investigations, Gardner concludes that the vehicle of such paints should contain: boiled or bodied oils or products which dry to a fairly saturated film, oils which dry by semi-polymerization rather than oxidation, and oils which dry to a flat rather than a highly gloss surface; while the pigment should contain a percentage of: pigments which are coarse and which, therefore, tend to form films having a rough surface, pigments which are inert and which do not act as conductors of electricity, and pigments which are either basic or of the chromate type. The metal should be sanded if possible.

#### EXAMPLES OF CONCRETE DETERIORATION

Since most concrete is more or less porous to moisture, and since iron undergoes gradual decomposition in the presence of salt water, with consequent expansion in

volume, it is to be expected that reinforced concrete that comes in contact with brine, sea-water, or salt and moisture will ultimately disintegrate. It is not surprising, therefore, to find reinforced concrete piers, seawalls, and buildings in the neighborhood of the ocean in various stages of deterioration.

Today large reinforced concrete structures are used to house industries that employ large quantities of salt and brine, which are constantly spilled on the floors. In order to ascertain whether the concrete of such buildings had undergone any deterioration, the writer a few years ago examined a large number of them in many different cities throughout the United States; and in this paper he wishes to give a brief account of some of the cases of deterioration observed at that time. In practically all the buildings inspected, reinforced concrete floors which came into contact with brine had iron-stained cracks on the under side. These cracks, which nearly always ran parallel to the reinforcing rods, were usually very narrow, but they indicated, nevertheless, deterioration of the reinforcements, and would continue to grow as the disintegration of the iron progressed. Fig. 1, which is a photograph of a ceiling of a large reinforced building in Detroit, the floors of which are continually wet with brine, is a typical example of one of these iron-stained cracks in the early stages, and Fig. 2 shows a cracked horizontal beam supporting the floor of a reinforced concrete building in Chicago. In many instances, where the deterioration had been in progress for some time, the cracks were found to vary from  $\frac{1}{8}$  in. to  $\frac{1}{4}$  in. in width, and in some cases the deterioration had progressed so far that large pieces of

\*Gardner. Journ. Franklin Institute, 179, 313 (1915).

concrete had fallen, or were about to fall, leaving badly corroded reinforcements exposed, as illustrated in Fig. 3 (photograph taken in Buffalo). An examination of a number of pieces of this fallen concrete showed that in every case a quantity of iron oxide adhered to the concrete where it had come in contact with the reinforcing rods (Fig. 4), and that it was sometimes as thick as  $\frac{1}{2}$  in. Where the concrete had broken away from the reinforcements, the latter were usually so badly corroded that it was possible to remove thick layers of oxide with the fingers. In a few cases the deterioration had progressed to such an extent that the reinforcements had been completely converted into oxide. Fig. 5 shows pieces of iron oxide,  $\frac{1}{2}$  in. to  $\frac{3}{4}$  in. thick, which were pulled away from corroded reinforcements or beams with the fingers.

A few details regarding particular cases of deterioration observed in some of the reinforced concrete structures examined may be of interest.

The ceiling of a machine-shop of a reinforced concrete plant in East St. Louis was found to be very badly damaged. This building, at the time of inspection, was about ten years old. The upper side of the ceiling was continually wet with brine, which continually leaked through to the under side and wetted it in a number of places. On this ceiling large brown iron-stains were numerous, and in at least twenty places pieces of concrete had fallen, leaving badly corroded net-iron reinforcements exposed. In one place, a piece of concrete 12 ft. long and varying from 2 in. to 18 in. in width had broken away. The reinforcements of this ceiling were imbedded at a depth of about  $\frac{1}{2}$  in. from the surface. Photographs of this ceiling are shown in Figs. 6, 7 and 8. Examples similar to these have been observed by the writer in Chicago, Kansas City, Detroit, and Buffalo.

At a plant in Kansas City that were found several very interesting cracked reinforced concrete pillars which supported a reinforced concrete platform at the top of an outside staircase. Large quantities of salt were used in the plant, and the platform was often wet with brine. The cracks on these pillars ran parallel to the longitudinal reinforcing rods. In some places the concrete had fallen away from the rods, which were badly corroded, and in other portions of the concrete were easily pulled away. Photographs of these pillars are shown in Figs. 9 and 10.

At another plant in this city there was a long outside platform, from which cars were loaded, covered by a reinforced concrete roof. At one end of this roof there was a pile of rock salt, which was partially protected from the weather by a wooden roof. Rock salt had been stored in this place for years. For a number of yards beyond where the salt was stored it had been spilled continually on the concrete roof, and owing to rains, perhaps a quarter of the roof was frequently wet with dilute brine. On the under side of the roof, directly below this place, there were many brown iron-stains, wet patches, salt deposits, and in one place the concrete had fallen, leaving the net-iron reinforcements exposed. These had deteriorated to such an extent that the outer portions crumbled on touching and some of the rods were easily pulled away. The area from which the concrete had fallen was at least one square foot. The individual rods of the exposed net-reinforcing, originally about  $\frac{1}{2}$

in. in diameter, had increased to about  $\frac{1}{2}$  in. in diameter, owing to the conversion of the iron into oxide. Some of these rods had disintegrated to such a degree that the sound iron core was less than  $\frac{1}{8}$  in. in diameter. Near where the concrete had fallen, it was evident that the expanding reinforcements were gradually forcing the concrete downward. At the far end of the ceiling, where salt had not been spilled above, there was no evidence of deterioration and the concrete was in an excellent condition.

At a third plant in Kansas City, a five-year old reinforced concrete basement ceiling was found to be in a very bad condition. This ceiling was reinforced with  $\frac{1}{2}$ -in. twisted iron rods. The floor above was more or less wet all the time, and in places salt came in contact with the water, forming brine. There were many cracks on this ceiling, some of which were sufficiently wide to insert a lead-pencil. One such crack was 20 ft. to 30 ft. in length. In several places large pieces of concrete had fallen, leaving corroded reinforcements exposed. In one place a large piece of concrete which was almost dropping and which weighed about 25 lb. was easily pulled away from the reinforcements. The under side of this, as is usually the case, had a large portion of the corroded reinforcements adhering to it.

The writer examined a building in Kansas City which contained a large quantity of reinforced cinder concrete that came into contact with considerable amounts of brine. This concrete, which was thirty years old, was in a very damaged condition, and in many places very large pieces had fallen.

In one of the Chicago plants examined, a whole floor had collapsed about a year previously, owing to the weakening of the reinforcements by disintegration.

Similar cases to the foregoing have been found by the writer in a number of cities in different parts of the country. Excellent examples of deterioration of reinforced concrete found in Buffalo are shown in Figs. 11, 12, 13 and 14.

#### WINTER POURED CONCRETE SHOULD NOT BE SALTED

When concrete construction is carried out in winter, it is sometimes the practice to add salt to the concrete to prevent freezing, often as much as 20 per cent being added. The writer has examined a number of reinforced concrete structures where salt had been mixed with the concrete during construction. As is to be expected, where the concrete comes in contact with water or moisture, there are manifold evidences of deterioration; but, on the other hand, where the concrete has been kept dry no damage has been observed. An example of deterioration due to this cause is shown in Fig. 15.

Examination has been made of a number of reinforced concrete tanks used for storing both water and brine. In all of these tanks it was observed that the liquid slowly percolated through the concrete, that the inside surface of the tanks was soft, and that, although these tanks had only been in use for less than a year, the strength of the concrete was much less than the normal strength. These effects were much more marked in the tanks which were used for storing brine.

The following conclusions are drawn by the writer from his investigations of the action of salt, brine, and sea-water on reinforced concrete:



1. All concrete which is not waterproofed in some way is more or less porous to water and brine.

2. Brine readily softens the surface of concrete, and, therefore, more easily penetrates to the reinforcements, on which it exerts a disintegrating action that, owing to the attendant expansion, gradually weakens the concrete, causing it to crack and split, and in some cases to fall away from the reinforcements.

3. The more porous the concrete, the more rapid the disintegration of the reinforcements through the action of brine.

4. Reinforced concrete floors which come in contact with brine will gradually develop leaks. These will be followed by incrustations of discolored salt on the under side, where, later, iron-stained hair cracks will develop, running parallel to the reinforcements. As the deterioration progresses the cracks will widen, and, owing to the great expansive force of the accumulating iron oxide, the concrete will be gradually pushed from the corroded reinforcements and ultimately fall.

In view of the foregoing conclusions it is evident that reinforced concrete immersed in brine or sea-water is liable to subtle and persistent deterioration, due to electrolytic action between the salt and the reinforcements. Therefore, the permanence and durability of reinforced concrete ships is a matter of considerable doubt, unless the sea-water is prevented from coming in contact with the reinforcements. Such prevention may be effected by coating the reinforcements with the protective paint, such as has been described, or by applying to the outer surface of the concrete some material which will render it waterproof. Since most of the substances which have been used for this purpose give results which are far from satisfactory, the writer suggests that good results might be obtained by coating the concrete with a very thin layer of a suitable metal by means of the Schoop Metal-Spraying Process. Finally, concrete that is to be used in the construction of ships should undoubtedly be made from cement of fine pulverization, low in alumina and high in silica, free as possible from gypsum, absolutely free from lime, slow in setting and quick in hardening.

Department of Chemistry,  
Swarthmore College,  
Swarthmore, Pa.

## War Department Authorizes Construction of New Plants

Authorization to proceed with the following building has been given to the Construction Division of the Army.

The construction of a phosphorus plant at or near Fairmont, West Virginia. The estimated cost is \$500,000 and the contract has been let to the American Phosphorus Company.

The construction of a tetryl plant at Senter, Michigan. The estimated cost is \$250,000. The foregoing amount is divided into the cost of the construction of the necessary buildings and equipment, included in which will be the boiler and power houses, facilities, packing houses, magazines, tramways and, in fact, everything to make a complete plant.

Additions and extensions to the Frankford, Penn., arsenal have been begun under the direction of the Construction Division. It is estimated that these will cost

\$1,000,000. The work consists of the extension of the loading room, annealing rooms, action press shop, barrack buildings, additional storehouses, stable, carpenter shop, a forging plant with equipment, a sea-wall along Frankfort Creek and other work to facilitate the production program at this point.

## Furloughs and Deferred Classification for Chemists

The Chemical Warfare Service has been duly authorized, by order of the Secretary of War, to make the necessary arrangements through the Adjutant General's Office to secure furlough, without pay or allowances, of such chemists as are necessary in such Government Bureaus as the Bureau of Standards, Bureau of Chemistry, Bureau of Mines, United States Patent Office, where such chemists are engaged in chemical work for the Government, or State Bureaus concerned, essential to the prosecution of the war. At the same time they are advised that the new Selective Service Regulations to be published shortly, will emphasize to the draft boards the fact that skilled employees of war industries should be placed in deferred classification. The induction into the military service of skilled men necessary to essential industries or occupations, to be subsequently furloughed back to their industries or occupations, involves an expense to the Government, and the men concerned lose time from their necessary work. The Bureaus concerned are authorized by the Selective Service Regulations to submit to the draft boards affidavits and written proof to maintain their contention that their employees should be placed in deferred classification and it is believed that they should be encouraged in securing deferred classification rather than securing the furlough of the men after they have been inducted into the military service. Communications relative to the matter should be addressed to Major Victor Lehner, C.W.S., 7th and B Streets, Washington, D. C.

## Carborundum Refractories

The article on this subject by Mr. C. S. Linbarger published in our daily issue for September 27 was originally presented at the meeting of the American Ceramic Society, New York City, September 26. Through an oversight we failed to give the customary credit to the Society, and due acknowledgement is made herewith.

## Imports of Rubber to January 1, 1919

The previous rate of permitted importations of crude rubber, effective up to Oct. 1, 1918, has been continued by the War Trade Board, in a new ruling (W. T. B. R. 248) for the final quarter of the year. Importations of crude rubber from overseas during the months of October, November and December, 1918, will therefore be limited to 25,000 tons, or at the rate of 100,000 tons a year. One-fourth of this amount will be licensed only from Central and South America. The remaining three-fourths may be licensed from any country. The amount so permitted to come forward will be allocated by the Bureau of Imports along the general lines of the previous allocations (Rulings 115 and 238).

## Development of the Magnesium Industry\*

BY LEONARD WALDO

**I**N THINKING over this subject the question arises whether there is, as yet, a development of the Magnesium industry on any such scale as we American engineers would call a development. I think of the time 35 years ago when in the Cowles works at Lockport, we had first harnessed Niagara at the overflow of the Canal Locks and had commenced with much fanciful hope the production of aluminium, which was, with its lightness going to decrease the weight of railroad carriers and metal structures by two thirds, and, because of its universal presence in the earth's crust was to displace the less abundant and heavier copper and iron, in many engineering enterprises.

Alas, the unthought of prevailed; the inertia of the world's customs, traditions and industrial practices made for a delay of years until aluminium should find its place and its comparative qualities should be widely known. Then the opening for its use occurred in a totally unexpected direction. It was found that the quality of steel could be improved by its use and thereafter a sufficient quantity of aluminium was produced to place its manufacture on a marketing basis, until now with the war demand, it is probable the annual production in our country of the Aluminum Co. of America amounts to 400,000,000 lb.

With this example of trade inertia before us, it is not surprising that magnesium would have to seek its natural applications before its manufacture could be placed on a basis at all commensurate with the more important metals. We find that in 1883 for instance, the European price of magnesium of 99.7 per cent purity was \$32.43 per lb. and that in 1902 with a world's output not far from 2500 lb. the price per lb. was \$2.82, approximately the price at present fixed by the United States government.

Magnesium has been known to metallurgists as a Cinderella sister to aluminium. It had such greater powers as a de-oxidizer in steel practice that the first attempts to use it commercially resulted fatally to the workmen. In action with the thermit process, it again showed uncontrollable vigor. In weight it is but 63½ per cent as heavy as aluminium and weighs 109 lb. per cubic foot. It exceeds in electric conductivity an equal weight of aluminium. It has a more beautiful color and is stronger than aluminium. Its specific heat is very high, ranging from 0.24922 between 20 and 100 deg. C. to 0.43516 at 625 deg. C., more than twice that of iron. Its oxide fuses at a temperature higher by 800 deg. C. than alumina. Peculiar and unexplained phenomena were noticed in the combustion of magnesium in the air. Woods showed that more heat was developed for equal amounts of oxygen taken up than in the case of any other known metal.

### COMBUSTION OF MAGNESIUM FOR LIGHT

Rogers as early as 1892 announced that the spectrum of burning magnesium more nearly resembled that of the sun than did any artificial illuminant; although the character of the spectrum, if it is due to ordinary in-

candescence, corresponds to a temperature of nearly 5000 deg. C.; while the radiant energy emitted is 75 per cent that of the total heat of combustion, and the light-giving power of magnesium per unit of energy expended is from 50 to 60 times that of gas. Later Nichols showed that incandescent magnesium emits light under conditions different than carbon and that it is more like the sun than that of any other source; that it is ten times as brilliant in the violet as the gas flame for equal luminous intensities, and one-half less in the red: also it surpasses that of the arc lamp in the yellow. Nichols assumes that here the law of radiation differs essentially from that of the ordinary incandescence. Can it be that we are encroaching on the ground of light production without the corresponding emission of heat? It is to be hoped that the activity of the U. S. Bureau of Standards along the lines of light emissivity as connected with the temperature of the highly refractory oxides, may not have to be curtailed on account of other war work researches, since it has a direct bearing on illumination for making photographic records of our war operations.

### COMBUSTION OF MAGNESIUM FOR RAPID THERMAL EXPANSION OF GASES

Closely connected with the luminescence of magnesium combinations is that of its relation to high military explosives. Its quickness of action in depriving nitrates, chlorates, manganates, sulphates and peroxides of constituent parts of oxygen with the accompanying extremely high temperatures instantly effective for expanding the volume of the released gases and other volatilized constituents gives magnesium a position among the best of explosive agents.

Here again we would be greatly benefited by a greater knowledge of the chemistry and physics of high temperatures; in fact, we know very little of the reactions taking place above, say, 1200 deg. C. in metallurgy. The few things we have discovered in these high-temperature regions are so helpful to war efficiency that it would be good if our researches were more extended in this difficult field. For example, the whole theory of the formation of the compound carbide of chromium, tungsten, and iron and their freeing at high temperatures to prevent the reversion of the reaction is the very basis of high-speed tool-steel production and hence the production of heavy ordnance on the lathe.

I cannot, for obvious reasons, at this time and place go into details as to present processes or results. I have mentioned these two recent applications of metallic magnesium to show that here we have an unexpected development, which sufficiently increases the demand for the metal to warrant the necessary capital, diversions of water-power and competent engineering to supply an amount large enough to tax present facilities and to encourage their rapid extension. We have, therefore, in the use of magnesium as an illuminant and as an explosive, the analogue to the use made of aluminium as a so-called deoxidizer in the case of steel. It is possible now to dismiss the market question for magnesium and consider some of its other uses.

### USES OF MAGNESIUM IN ALLOYS

For the last ten years or more, the cupro-magnesium alloys for scavenging brass have been a successful

\*A paper read at the Fourth National Exposition of Chemical Industries, New York, Sept. 27, 1918.



marketable product and thanks to our own brilliant and lamented Edwin Star Sperry, they obtained a place in copper alloy furnace work. The cost however limited their use. Probably with the present needs of greater economy in saving wastes in the casting shop and the higher prices obtained, the use of cupro-magnesium can now be put on a profitable basis as also the collateral use of metallic magnesium for controlling the pitch of copper in the reverberatory.

It was fortunate that in the establishment of the manufacture of magnesium by the Cuniff Brothers at Rumford Falls, Me., that a process for recovering the metal from a pure magnesia by-product was adopted. The early development of aluminium had been greatly hindered by the use of impure materials, and it is said by engineers to-day that the manufacture of aluminium sufficiently pure for modern metallurgy is entirely a question of making pure alumina. Modern alloys require a purity on a par with lake or electrolytic copper, Bertha zinc and Straits tin. The early aluminium alloys suffered greatly from such impurities as iron, silicon, and sodium. The present magnesium alloys fortunately are starting with an all but c.p. magnesium.

Of the flotilla of alloys using magnesium now streaming into the ocean of commerce, some have already been long enough in service to show what time, vibration, gaseous corrosion, alternate stresses, and water-vapor both on sea and land will do for them. Notable among these are "magnalium," of which there is a description in *Engineering* (London) for Jan. 5, 1906, and "dur-alumin" as described by Wilm in *Metallurgie* for 1911, pages 225-227.<sup>1</sup>

In these alloys, the specific gravity is kept near the 2.75 of pure aluminium. In other commercial alloys sold as aluminium, the specific gravity of the pure aluminium is increased by the addition of zinc or copper to about 3.2; but by the use of magnesium to replace such zinc or copper, the specific gravity would be somewhat reduced and we would have commercial aluminium alloys of 81 lb. replacing the same sizes of present aluminium of 100 lb. weight.

Some of the alloys of magnesium with aluminium are of extreme beauty; notably those which correspond to the eutectic, which is formed when the metals are combined in nearly equal proportions, the color of which is an ultra silvery whiteness and the texture, when the final meltings are made free from occluded gases, of microscopic fineness. This series is of great value for reflection of light in telescopes, in plane and curved mirrors. Because of its brittleness, an alloy of equal or nearly equal proportions lends itself to those powdering process where rotating hammers or stamp mills are used. Here, as in all processes for mixing powdered magnesium precautions are necessary to avoid explosions.

Years ago at Bridgeport we made certain small ingots for unknown but cash-paying customers, of rich-colored yellow aluminium bronze. Months later, we identified those same ingots in the police court after having been sold for genuine gold bricks. I am reminded of that occurrence as I think of the opportunity for the magnesium business now that this beautiful metal has come to stay, and is being made, to insure

purity and rapid production, from such costly sources as the magnesium-potassium alkali-chlorides, where there is but 7.3 per cent of metal available or of other chlorides where there may be 10 per cent! Think of the magnesitic ophiolite in Canada with its 42.5 per cent bulk of magnesium, or of Salt Lake, Utah, with its 0.56 per cent of magnesium, or of Old Ocean himself with his  $\frac{1}{2}$  of 1 per cent at our feet. As for other sources, besides carnallite (natural or artificial), we have kieserite, magnesite, dolomite and in fact some 51 out of 768 minerals, and the bitterns of the sea in collecting sea-salt. In ordinary sea water, a cube of 30 feet dimensions contains a 2240-lb. ton of magnesium.

Current production, with two plants of the American Magnesium Corporation at Niagara Falls, N. Y. and Rumford Falls, Maine, formed by the merging of the company of that name with the Rumford Metal Co., may be considered larger than that for the first half of 1918, which according to the United States Geological Survey was 116,938 pounds.

The time has not yet come for the prototype of Captain A. E. Hunt's classical paper on the "Manufacture of Aluminium by Electrolysis and the Plant at Niagara for its Extraction" published in the *Proceedings* of the Institution of Civil Engineers in 1896, but within a few years to come, with war conditions removed, it will be possible to reveal to the full the technique of production and the power and capacity in manifold directions of the most attractive of all metals—magnesium.

---

The President has approved the maximum prices on sulphuric and nitric acids, fixed at a meeting between the Price Fixing Committee and the manufacturers on September 26, 1918, these prices being effective from September 30, 1918, to December 30, 1918.

---

### Control of Tin Imports

B. M. Baruch, chairman of the War Industries Board, announces that under the recent decision of the War Industries Board to take control of the domestic pig tin situation by a license system the United States Steel Products Company only will be granted import licenses, this company to act under government direction and in the interest of consumers.

All users and dealers in pig tin will be licensed, and will secure their future requirements of pig tin from the United States Steel Products Co., which will make distribution under the direction of the War Industries Board.

The Inter-Allied Tin Executive, who will carry out the terms and agreements of the Inter-Allied Pig Tin Pool recently arranged in London, will control the buying price in each producing market. The War Industries Board will control the prices and terms under which the pig tin is to be sold to the domestic users and dealers.

Preliminary to the issuance of licenses to the users and dealers in pig tin an inventory of stocks on hand and contracts unfilled by the 2000 odd individuals and plants affected is being made by the Tin Section of the War Industries Board. If necessary, there will be a re-distribution of the stocks on hand to equalize them according to essential uses.

<sup>1</sup>See also this Journal Oct. 1 and 15, 1918. Aluminium and Its Light Alloys, by Paul D. Merica.

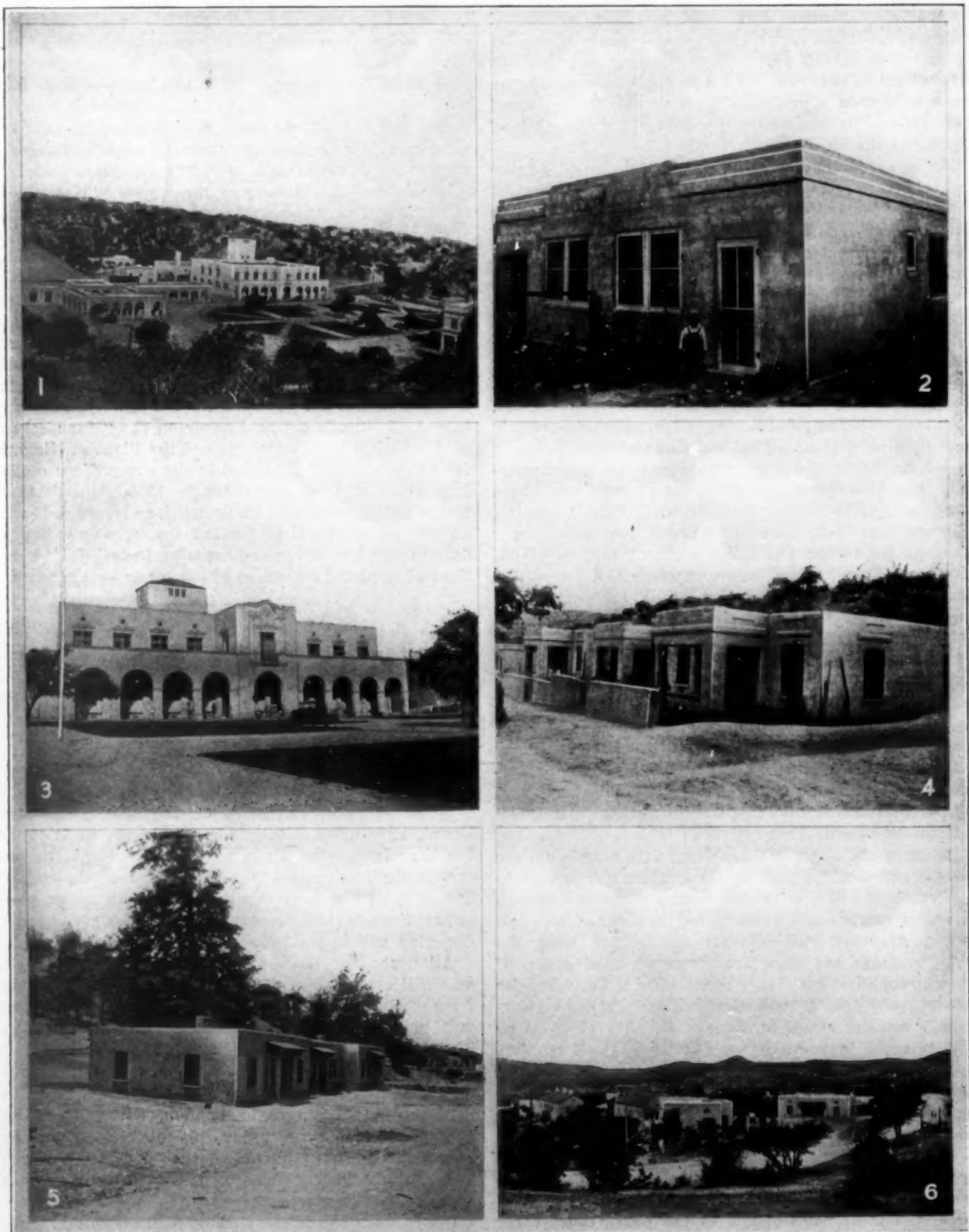


FIG. 1.—THE PLAZA AND HILL RESIDENCE  
 FIG. 3.—PHELPS DODGE MERCANTILE CO. STORE  
 FIG. 5.—NEW TYPE G HOUSE

FIG. 2.—TYPE H HOUSE; FLOWER BEDS AND WAR  
 GARDENS  
 FIG. 4.—OLD TYPE G HOUSE  
 FIG. 6.—"THE HILL" RESIDENCES FOR AMERICANS



## Housing at Tyrone, New Mexico

**An Account of the Systematic Efforts of the Phelps Dodge Corporation to Provide Wholesome Living Conditions and Harmonious Surroundings for Its Employees—Not An Experiment in Philanthropy, but a Wise Business Policy**

BY CHARLES F. WILLIS

Consulting Supervisor Department of Industrial Relations,  
Phelps Dodge Corporation

IT IS BELIEVED that when the engineers of the Phelps Dodge Corporation first investigated the property now known as their "Burro Mountain Branch," the attractions of climate and the environment of Tyrone must have entered into consideration, for today this place may be described by an adjective that seldom fits a mining or smelting community—it is a charming spot.

Were it not for the newness of the buildings, one could almost imagine that he was in a prosperous town in old Mexico. The buildings carry out the extreme Spanish type of architecture, with their plastered walls in various pale tints of blue, pink, gray and tan, the plaster laid unevenly as was done in the days when plasterers were not as skillful as at the present time, the roofs of vari-colored tile, everything Spanish to the last detail. One would imagine that the buildings were all of adobe until he watched a new building in the process of construction and saw the wooden frames, the wire lath on the outside and button board on the inside. The charm of the Spanish type is there, however, in the crooked corners of the window casings, the "hand hewn" timbers, aged with burnt umber, and, true to type, we further find that most of the buildings are occupied by Mexican laborers.

### GENERAL LAYOUT OF VILLAGE

It is indeed fortunate that this property was purchased by an organization with broad policies, as it would have been a pity to have put an ordinary camp in the site which Tyrone occupies. The long, broad valley of the Mangus River, eleven miles out of Silver City, formed the axis line for the center of the town, and from this valley at right angles, several smaller valleys branch, of sufficient size, however, to provide for the laying out of a street with houses on both sides. One pictures a typical street of an industrial community as a row of box-like houses, all alike on the outside and with interior details identical. As is shown by an inspection of Table I, this has been avoided in the Tyrone project by the adoption of some twenty odd houses, the types so scattered that it is unusual to find two alike in the same neighborhood.

The town was primarily laid out in sections. The community center is of course the plaza, surrounded by a group of fine buildings. Radiating from this are numerous canyons, each assigned to a definite purpose. On the southwest is Pinal Street, the lower end of which is built up with what is known as Type G, H, K, and J apartments. These two- and three-room houses, shown in Figs. 4 and 5, are designed to be rented to Mexican laborers who wish homes at low rentals—from six to

twelve dollars monthly. The upper end of this street is surveyed in lots to be leased to Mexicans at a very nominal rental, where they may build their own homes. On the west side, leading directly out of the park, is Bellotal Avenue, bordered by similar houses for the Mexicans, as well as by a branch canyon from Bellotal Avenue, called Encinal Street. On the northwest side of the square is Fortuna Street, which leads up another canyon divided into lots which are leased to Americans with a \$1000 building restriction. On the southwest side is Coronado Street, subdivided for Americans into lots with no building restrictions. Leading from the plaza and winding up and over the hills to the mine is what is known as "the Hill," and along the well-graded roadway are fine residences for Americans. As seen in Fig. 6, there is no regularity as to their location or their setting, and they are of many different types.

### PHELPS DODGE POLICIES

Tyrone is distinctly a company-owned town; no land has been sold nor is it planned to sell any. There are advantages and disadvantages in living in a company-owned town, depending upon the policies of the company; fortunately for Tyrone the Phelps Dodge Corporation is particularly liberal. The store of the company (Fig. 3) is located in a prominent place on the plaza, but almost directly opposite is the fine building shown in Fig. 7 which has been leased at a very low figure for an independent store, in order to give their own store competition. This is the case in all lines of business, competitors being supplied with the necessary quarters to compete with Company enterprises. Every effort is being made to make it a town where the cost of living is low and to a great extent these efforts have been rewarded. The policy of the company is to have satisfied workmen who will stay with them year after year, who appreciate homes and who know that the company cares for their well being as well as for the profits from their properties. It is not by any means an experiment in philanthropy, but rather a policy of far-seeing men who recognize that the development and building of the community simultaneously with their business will bring greater profits, indirectly, but surely. They believe that it will pay dividends in content and in the reduction of labor turnover.

### THE PLAZA

The plaza is surrounded by a group of fine business buildings, harmonious in type of architecture, but all different in detail. On the east side is the company office building (Fig. 8) containing the offices of the officials, the townsite department, and the engineering,

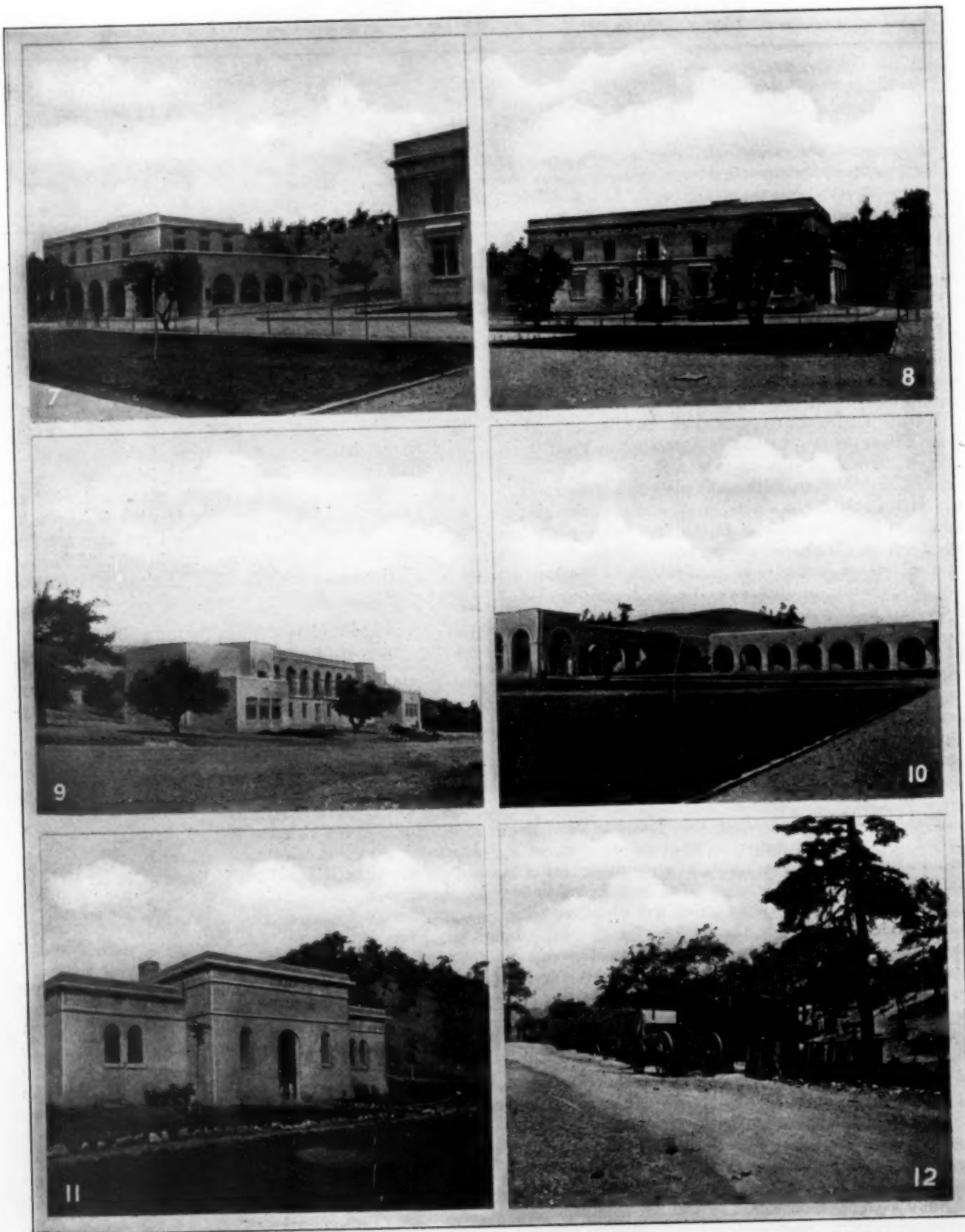


FIG. 7.—INDEPENDENT STORE  
 FIG. 9.—PUBLIC SCHOOL  
 FIG. 11.—THE JAIL

FIG. 8.—OFFICES OF THE PHELPS DODGE CORPORATION,  
 BURRO MOUNTAIN RANCH  
 FIG. 10.—RAILROAD STATION AND POST OFFICE  
 FIG. 12.—PINAL ST.; HOW MEXICANS LIVE WHEN LEFT  
 TO THEMSELVES



bookkeeping, and auditing departments. On the northeast corner is the independent store, a confectionery, a refreshment parlor, a barber shop, a doctor, a dentist, a lawyer and a photographer. On the northwest side will be the employees' club house, yet to be erected. Beside the club house is a large school (Fig. 9) and in spite of the fact that the town has only four thousand people, it is reputed to be the best school house in the state of New Mexico. That Tyrone is being selected by workers as a place to bring up their families is evidenced by the attendance at the school. Although it was designed to be large enough for some years to come, the six hundred students attending last year made it necessary to erect an addition. The building was built by the company and leased to Grant County at a very nominal rental.

On the west side of the plaza is the department store of the Phelps Dodge Mercantile Co. (Fig. 3), and while large centers of population may boast of stores of greater floor space, they cannot boast of a more beautiful building. On the southwest corner is the railroad station and post office building, both of which are fitted to carry out the same general scheme, while on the southeast is to be the hotel, work on which has been stopped for the period of the war. Situated but a short distance away from the plaza and yet readily accessible to it is a garage, a large restaurant and a moving picture theater, and the company has even taken upon itself to build the "hoosegow" or jail in a pretty little park (Fig. 11). A central heating plant provides for all of the buildings surrounding the plaza and for carrying out the Spanish type of architecture; where steam radiators would seem out of place, the radiators are carefully concealed in the walls, under the seats in the station, and by various ingenious devices. The plaza itself is a beautiful spot with large grass areas, and will soon be equipped with the necessary band stand. The absence of "keep off the grass" signs is noticeable, the management believing that grass plots are made to use rather than to see.

#### DETAILS OF THE HOUSES FOR LABORERS

In the type of houses designed for the Mexican labor there are electric lights, sewer connections, water and gas. The type G house has six two-room apartments, which rent for \$6 per month; type H is a double two-apartment house renting for \$8 per month; type K has two three-room apartments which rent for \$9 per month, while type J is a single three-room house renting for \$12 per month. The other types vary from two to six rooms, renting at about \$5 per room. Types G, H, J, and K houses have flush toilets on the outside as a separate structure, although in the latest type G they are inside. Each room has electric plugs for iron, toasters, percolators and other electric devices. The earlier houses have cement floors in both the front and rear rooms, but the latest have wooden floors in the front and cement in the back.

The housing project of Tyrone was started in the summer of 1915 and besides the central plaza and its group of large buildings, 229 apartments have been built to date, and more are in the process of construction. One of the results has been the education of the Mexican laborer to better methods of living. At first it was found that the Mexicans preferred to rent a piece of land at fifty cents per month and build their own

shacks like those of Fig. 12 rather than rent a company house. However, the houses are now taken up by a waiting list and cannot be built fast enough. Moreover, there is a growing demand from the Mexicans for larger and better houses having three or four rooms and bath.

#### GENERAL RESULTS

Tyrone is a spotless town. The sanitary squad cleans the streets, empties garbage and does various other duties to keep the town clean. No charge is made the tenants for this service. Electricity is sold for seven cents per kw.-hour with a minimum of 50 cents per month. Water is furnished for 50 cents per thousand gallons with a minimum of three thousand gallons per month, with an additional cost of 35 cents per thousand gallons for a garden. The management is now planning



FIG. 13.—THE T. S. PARKER HOSPITAL

the diversion of some of the mine water, however, to take care of the latter.

TABLE I  
DESCRIPTION AND NUMBER OF PERMANENT BUILDINGS FOR  
RESIDENCE PURPOSES FULLY COMPLETED AND OCCUPIED

Jan. 26, 1918 Tyrone, New Mexico						Appurtenances
Type	Monthly Rent	Number of Buildings	Number of Apartments in Bldg.	Number of Families Accommodated	Number of Rooms in Apartment	
B	\$30	2	Single	2	5	Bath, sleeping porch, fireplace (1 with garage)
X	30	4	Single	4	5	Bath, sleeping porch, fireplace (2 with garage)
Z	28	2	Single	2	4	Bath, sleeping porch, fireplace
O	27	3	Single	3	4	Bath, sleeping porch, fireplace (1 with garage) (1 only with fireplace)
U	27	3	Single	3	4	Bath, sleeping porch, fireplace, garage
R	25	3	Single	3	4	Bath, no sleeping porch (1 only with fireplace)
S	25	2	Single	2	4	Bath, no sleeping porch, fireplace
SS	24	1	2	2	4	Bath, no sleeping porch, fireplace
V-Lower	25	1	3	1	5	Bath, no sleeping porch, fireplace
V-Upper	20			2	4	Bath, sleeping porch, no fireplace
W-Upper	23	2	2	4	4	Bath, sleeping porch, no fireplace
W-Lower	20				4	Bath, no sleeping porch, fireplace
P	20	2	Single	2	3	Bath, no sleeping porch, no fireplace
2	20	1	Single	1	4	Bath, no sleeping porch, no fireplace
4	20	1	Single	1	4	Bath, no sleeping porch, no fireplace
M	18	2	2	4	3	Bath, no sleeping porch, no fireplace
3	18	1	Single	1	3	Bath, no sleeping porch, no fireplace, garage
N	15	1	2	2	3	No bath, no sleeping porch, no fireplace
L	14	2	2	4	2	Bath, no sleeping porch, no fireplace
J	12	4	Single	4	3	No bath, no sleeping porch, no fireplace
K	9	6	2	12	3	No bath, no sleeping porch, no fireplace
H	8	6	2	12	2	No bath, no sleeping porch, no fireplace
G	6	26	6	154	2	No bath, no sleeping porch, no fireplace
I	27	1	Single	1	5	Bath, no sleeping porch, no fireplace
Mine Supt.	65	1	Single	1	6	Bath, sleeping porch, fireplace, furnace garage in cellar

## The Rôle of Colloids in Chemical Processes\*

IN a recent conversation with a chemist well known throughout the country for his contributions to industrial research, he remarked: "There seem to be fashions and styles in the problems that are brought to us. Sometimes these are mostly of a metallurgical nature, at other times they are inorganic or again organic, while of late, the bulk of the problems that have come before us are in the realm of applied colloid chemistry."

Some of us, too, studied the subject when the memory of Thomas Graham was under a cloud of neglect, or in Germany before Wilhelm Ostwald washed the cloud away to find a field of distinction for his son Wolfgang. Then, as we grow older, we read and forget, and need to have our memory jogged a little to refresh our consciousness of certain important things. With this purpose in view and to bring to the notice of our readers two forthcoming chemical books of importance, we shall extract a few notes on the subject in general and then proceed to add memoranda on applied colloid chemistry from the sources mentioned.

The colloid field has to do with the properties of particles of the approximate diameter of from  $0.1\mu$  ( $0.0001$  millimeter) to the point where crystalloidal solutions begin, which is less than  $10\mu$  ( $1\mu = 0.001\mu$ ). The smallest particles that can be seen with the ultra-microscope are of about  $5\mu$  diameter. The theoretical H molecule is about  $0.1\mu$ . Then if a human red blood corpuscle were  $25$  ft. in diameter by way of comparison,  $5\mu$  would be quarter the size of a man's finger nail and the H molecule would be hardly more than a speck. Now since it is the surface of these particles which presents their most distinguishing characteristics, let us observe that while one cubic centimeter presents a surface area of  $0.93$  square inches, if it were divided into  $0.1\mu$  cubes we should have  $1,000,000,000,000,000,000$  cubes presenting a surface area of about  $21\frac{1}{2}$  square feet. And if we were to divide it into cubes of  $0.1\mu$ , we should have a million million million cubes presenting a surface of nearly fifteen acres.

We are constantly considering the wandering of particles but sometimes an example is worth while, to show their ways. Here, for instance, is one that is graphic: If we give a man a few grains of lithium chloride and shortly afterward wipe his forehead with a clean platinum wire, the lithium will show in the spectroscope. With the Faraday-Tyndell effect, however, in a solution of  $0.1\mu$  colloidal gold, less than one ten-millionth of a milligram may be detected with the naked eye.

As colloidal particles coalesce, energy seems to be developed. This manifests itself (or "orients" itself as is said in translations, from the German "*orientiert sich*") as lightning in the case of clouds or as heat in the case of metals. Here is a grand field for study and the most delectable playground for speculation.

Protection in the colloidal sense produces a surface skin or pellicle which surrounds each particle and prevents it from coalescing with others. It exercises a

two-fold function: In crystalloid solutions it provides that reactions take place in detail as it were rather than *en masse*, or, to use a foot-ball simile, it provides for contact in open formation rather than by a flying wedge. After the aggregation of crystalloid particles into those of colloid dimensions it surrounds these and prevents their union.

Let us note at this point that the radius of molecular attraction is about  $50\mu$  or just within the colloidal field.

*Adsorption* is a phenomenon that goes farther than some of us are disposed to think. For instance, a solution of  $K_2SO_4$  filtered through sand gives a dilute solution of  $H_2SO_4$ . Dissociation has taken place. This fractional dissociation is more observable in electrolytes, for certain salts dissolved in a gel dissociate, and some of their ions diffuse faster than others so that complete separation may take place. Very pretty experiments may be performed in this connection by the use of different indicators in a test tube. Ions of crystalloid electrolytes receive an electric charge as they are adsorbed by colloidal particles and this results in stabilizing the dispersion. As the iso-electric point is reached, where the charge equals zero, coagulation occurs.

The application of colloid chemistry is so wide that we can give only selected memoranda on the subject.

*Clay and ceramics.* The first historical note we get is in the fifth chapter of Exodus, where it is recorded that the Egyptian taskmasters compelled the children of Israel to make bricks without straw. The use of the straw was not, as is generally supposed, on account of the fibres which served as binders. It was a colloidal substance contained in the straw which caused the particles to deflocculate. Recent patents have been taken out for "Egyptianizing" clay by adding to it tannin, extract of straw, humus and the like. Protective colloids such as glue etc. deflocculate or "free out" clay and make it spread or cover, as in paper coating and kalsomining. The working properties of clay depend largely upon the size of the particles and their state of aggregation. This explains the uselessness of chemical analyses which give only percentage content, if the clay is to be used for certain purposes. Articles moulded of clay and then burned lose their hydrosol condition and become hardened into pottery.

In agriculture it is colloid chemistry that is in large measure the chemistry of practice. The quality of soils has a great deal to do with organic colloids which are found in it, as well as with the size of the soil particles. We have not space even to touch upon this great field.

In electroplating the addition of protective colloids tends to the production of non-crystalline deposits.

*Metallurgy.* Since coarsely crystalline metals are brittle, tending to split along the line of crystal cleavage, various physical or chemical means are employed to obtain a fine hard-grained structure. Among the physical methods are chilling and rolling, while chemical methods involve the removal of undesirable constituents (as in the conversion of pig iron to steel) or the addition of desirable constituents (as in case-hardening or the manufacture of alloy steels). For instance, it is shown that the predominant effect of vanadium in steel is to decrease the size of the ferrite grains and to make the material harder; it renders the ordinary structure due to pearlite fine and homogeneous. While the question is one of great complexity, many facts at present

\*EDITOR'S NOTE. We have been permitted to look over the proof-sheets of Mr. Jerome Alexander's forthcoming book on "Colloid Chemistry" as well as his contribution of "The Practical Application of Colloid Chemical Principles" to the new edition of Rogers' "Industrial Chemistry," and we believe a few notes from them to be timely.



available seem to indicate that one of the causes favoring the fine-grained structure in such instances is the inhibition of crystallization by substances colloiddally dissolved in the molten mass. Thus, part of the carbon in iron and steel is graphitic, and as graphite is slightly soluble in iron, under proper conditions some of it will assume a colloidal form and act as a protector.

An interesting research note follows: Moissan said that the addition of a little platinum to metallic mercury caused the latter to emulsify in water. Upon making the experiment, according to Moissan, Mr. Jerome Alexander noticed that the supernatant liquid remained turbid. On standing, examination of the fluid in his ultra-microscope revealed the presence of colloidal metallic particles in active motion.

In dyeing, colloid chemistry throws light upon points which were heretofore obscure. For instance, it is possible to obtain more level colors in old dye liquors than in fresh ones, and the explanation proposed is that colloiddally dissolved substances are responsible for the phenomenon in that they exercise a restraining action upon the adsorption of color. They slow down the process. The level dyeing facilitated by the addition of Glauber's salt may be due to its action as an electrolyte producing a partial coagulation of the dye-stuff so that its particles, thereby made larger, are adsorbed more slowly and evenly.

**Soap.** The colloidal nature of soap solutions is indicated by their turbidity and their gelatinization. The detergent action of soap is consequent upon its deflocculating effect as was shown in the Cantor Lecture of H. Jackson (*Journal Soc. Arts*, 55, 1101, et seq.) who examined microscopically the supernatant fluid from washing a dirty cloth and found in it countless particles in a state of oscillatory motion ("pedesis"). When an individual fibre was bathed in soap solution, the dirt particles gradually loosened and began to oscillate, while upon substituting salt solution for the soap, the particles flocculated and the motion ceased. Mr. Alexander observes that an ultra-microscopic examination of the detergent effect produced by soap should prove of interest. The subject has long needed explanation and no one is better qualified to blaze the trail. The answer certainly seems to lie over in this field.

In regard to transparent soaps, there is a memorandum of an original experiment by the author which has a bearing upon metallurgy. According to W. D. Richardson, a transparent soap is a supercooled or supersaturated solution, having crystalline tendencies and exhibiting colloidal properties. Bearing in mind that the salts of the higher fatty acids dissolve in water as colloids and in alcohol as crystalloids, and also that alcohol or equivalent solvents such as glycerol, sugar etc. are used in transparent soap, it seems probable that the crystals which frequently form in it are due to the slow separation of such part of the soap as is in crystalloid solution. The crystalloid phase of soap is apparently governed by the same factors as those which Tamman pointed out as governing the crystallization of supercooled solutions: first, the specific power of crystallization; second, the speed of crystallization; and third, the viscosity. It seemed to Mr. Alexander, therefore, that an important factor in determining the transparency of transparent soap would be the speed of cooling, and he made some experiments

along this line. A piece of commercial transparent soap was melted and cast into two cups, one of which was quickly chilled in ice, while the other was allowed to cool slowly by immersion in hot water. The quickly cooled piece was transparent while the other was practically opaque and showed on ultra-microscopic examination much larger ultra-microns than the transparent piece. After standing three or four months, the quickly cooled soap was still transparent to the naked eye, whereas large opaque spots could be seen in the slowly cooled piece. In the ultra-microscope the former appeared as before, whereas the latter showed large and perfectly resolvable crystals in a clear matrix.

These experiments give us an inkling as to what occurs during the "heat treatment" and tempering of metals, and it is to be hoped that some technique may be devised that will give us even a clearer insight than does etching into the changes that occur in metals in heat treatment, use, age, and even "disease" (tin for example).

**Milk.** This product contains salts and sugar in crystalloid solution, casein and lactalbumen in colloidal dispersion and milk fat in suspension. Upon reaching the stomach the casein of cow's milk coagulates into great hunks; that of mother's milk into fine flakes; and that of mare's milk remains almost fluid. That cow's milk is indigestible by many persons and may not be taken with impunity by infants is well known. The addition of protective colloids to cow's milk stabilizes it and makes it act more like mother's milk when treated with acid and rennin. If sufficient protective colloid be added the coagulate may be kept in a very fine state of subdivision. Gelatin and gum arabic are used for this purpose. Sodium citrate also acts as a protective colloid.

Ice cream, as those who make it know, if made without eggs, gelatin or some similar colloidal ingredient, is gritty, grainy or sandy, or it will soon become so upon standing, whereas ice cream made with small quantities of protective colloids has the rich, mellow, velvety texture so much desired. The colloid acts as an inhibitor of crystallization and as a preserver of texture. It is also very beneficial from a digestive point of view. Nevertheless, some official food chemists of the type that use publicity bureaus for their laboratories and newspaper columns for their literature have been known to declare the expensive and desirable gelatin to be nothing but "filler," and have cautioned the public against it.

**Tanning.** The skins of animals constitute an organized colloid jelly formed of bundles of fine fibrils, about  $1\mu$  in diameter, bound together by a cementing material of similar chemical composition which is largely removed by liming and other treatment which precedes the tanning proper. When the swollen hide is placed in the acid tanning solution, the tannin is powerfully adsorbed by the fibre and combines with it to form leather. The positively charged hide and the negatively charged tannin naturally coagulate each other. If the tar liquor is alkaline, both the tannin and hide become negatively charged and no tanning occurs. Gelatin, when neutral and free from electrolytes, does not precipitate pure tannin, but in an acid solution it takes a positive charge and is tanned. The tanning process may be aided electrically by giving the

hide a suitable potential, positive in the case of tannin and negative in the case of chromium compounds.

**Rubber.** This product is made by coagulating the milky juice or latex of various plants. Rubber latices are emulsions stabilized by protective colloids (proteins or peptones) and the nature of the coagulant depends upon the nature of the protector. Vulcanization consists of the combination of sulphur with rubber. At first the sulphur is adsorbed; then by heating, part of it enters into a close combination, probably into a true chemical combination.

**Photography.** The photographic plate owes its sensitiveness to an emulsion of colloidal silver halides stabilized by a protective colloid (gelatin, albumen or collodion). The degree of dispersion is controlled by the condition of precipitation of the silver salt and the subsequent treatment of the emulsion. The latent image formed upon the exposure of the plate to light is probably an adsorption compound between colloidal silver and silver halides. This is an interesting definition of silver sub-halides and gives us a chance to think of bromine as mono-valent in this connection which is comforting to old-fashioned chemists who are likely to grow restive under the consideration of polyvalent halogens. It seems, under such conditions, as though the halogens had become addicted to evil practices.

**Cement, Mortar and Plaster.** When freshly mixed, mortar and cement contain colloidal sols or gels which gradually coagulate and set or bind the crystalline element of the plaster into a coherent whole. The setting of plaster of Paris has for many years been slowed down by colloidal retarders. Observations were made by preparing microscopic slides with equal parts of plaster of Paris and water to which had been added varying proportions of gelatin with the following results:

Per Cent Gelatin	Time to Set in Minutes	Microscopic Appearance of Slide
0.00	40	Characteristic interlacing crystals of calcium sulphate.
0.01	50	No true crystals except in a few spots where some colloid-free solution had diffused out. Elsewhere aborted spherocrystals.
0.10	260	No true crystals.
0.25	510	No true crystals.
0.50	960	No true crystals.
1.00	Not set in 48 hours	No true crystals.
2.00	Not set in 48 hours	No true crystals.

In chemical analysis the presence of colloids may lead to grave errors, so that the chemist should destroy them by ignition or overcome their effects by coagulation. Reversible colloids, often referred to as "organic matter," may prevent the formation of precipitates, just as tartaric acid or tartrates prevent the precipitation of alumina, chromic oxide or ferric oxide. They may also prevent the satisfactory filtration of the precipitate formed or they may render precipitates difficult to wash and purify. As an example, three solutions of lead acetate were taken. To the first was added HCl which yielded a heavy, coagulated precipitate. To the second was added NaCl (a less highly ionized precipitant) which yielded a colloidal precipitate of lead chloride. To the third was added first a little glue solution and then sodium chloride; in this no visible precipitate was formed.

**Foods.** Here is a sentence that in these days of domestic economy and Kitchen Chemistry should be learned by heart and repeated often: It is a serious

error to judge foods upon the basis of a bald chemical or calorific analysis; fat, protein, carbohydrate and calories are not alone the criteria of food values; the physical condition of food largely governs its usefulness to the organism. For instance, light bread is more wholesome than heavy bread because the former presents an enormous surface to the digestive juices. In biblical times, unleavened bread was eaten only in time of stress. Again, the meats of young animals differ from those of old ones in that the latter are formed of tissues partially dehydrated by age. Notwithstanding all our talk, we have not yet reached a proper appreciation of the great art of cooking.

#### BODY AND PLANT COLLOIDS

**Physiology and Pathology.** The changes which occur in almost all physiological processes are produced at comparatively low temperatures and in the presence of very dilute reagents. The living organism disintegrates proteins, oxidizes carbohydrates and with the same apparent ease synthesizes substances of great complexity. The body and plant colloids (biocolloids) consist of carbohydrates (starch, cellulose, glycogen), proteins (plant and animal albumens) and lipoids (lecithins, cholesterolin, fats and oils). Each tissue has a normal turgor or state of swelling which is greatly influenced by acids, alkalies and salts. The swelling and shrinking of tissues, together with their selective adsorption and the differential diffusion of solutions through them, account for or accompany many physiological phenomena, both normal and pathological.

Thus, fibrin and gelatin swell much more in very dilute acid than in distilled water, but the swelling is depressed by salts. Fibrin is so sensitive that it swells in the presence of traces of acid quite undetectable by ordinary indicators such as litmus; in fact, fibrin itself is an extremely sensitive indicator, and can by its swelling actually distinguish distilled water from the still purer conductivity water.

Local accumulation of acid in the organism may cause swelling (edema); for example insect stings, which may be imitated by stinging gelatin with a needle dipped in acid. If acid accumulates in an organ within a rigid capsule (eyes or kidneys) the swelling tends to establish a vicious circle (glaucoma, nephritis) by compressing the blood vessels and cutting down the alkaline blood stream, which is unable to wash out the acids (mainly  $\text{CO}_2$ ) formed by living protoplasm.

If the oxidation processes of the body are normal, the hydrogen in foods is oxidized mainly to water and the carbon mainly to carbonic acid, a gaseous acid which is exhaled without demanding protein or fixed alkali of the organism for its elimination. In the case of pathological oxidation, however, other acids are formed and a condition called "acidosis" may arise. This is in reality a diminished alkalinity, recognizable by the fact that an abnormally large quantity of bicarbonate of soda is needed to render the urine alkaline. These acids may cause not only disturbances of the body colloids, but disease and even death. In fact, throughout life there is a gradual syneresis of the biocolloids, accompanied by visible shrinking and loss of water as is indicated by the comparison of the chubby hand of a child with that of an old man. In plants an analogous process occurs in lignification.



## Potash in Nebraska

BY J. M. LLITERAS

IN 1912, when two students from the University of Nebraska filed claims on Jesse Lake with the purpose in view of extracting potash salts, no one thought they were starting an industry which a few years later was to be in the forefront in the State of Nebraska, and the industry which the farmers of the United States were to depend upon for their supply of potash fertilizer. These students, Show and Modesitt, tested various lakes in the "Sand Hills" of Western Nebraska and arrived at the conclusion that Jesse Lake would be the most profitable to them. The decision was a wise one, for there has not yet been found another lake equal to it. The Potash Products Co., and its successor, the Potash Reduction Co., has been drawing on Jesse Lake steadily for about five years, and it shows few if any signs of exhaustion.

There were many untouched lakes in this region, however, and today the present field from which the

shows conclusively that it is but a matter of time until the lake will fail to "come back." This will happen when the supply of salts to this particular lake has been exhausted. The reader may ask why it is that Jesse Lake, which was tapped first and has been drawn upon heaviest, has not given out. The answer is that the supply which is feeding this particular lake must be enormous, although it is not inexhaustible.

The loading stations for the Nebraska potash industry<sup>1</sup> are at Antioch, Hoffland and Lakeside, all situated on the main line of the Chicago, Burlington and Quincy Railroad, near the division point, Alliance. Since the small lakes are scattered over a large area, it is necessary to pipe the brine to a central evaporating station. Most of the brine used today by the various companies is pumped from wells, the depth of which varies from 12 to 30 ft., depending entirely upon the nature of the lake in which they are placed. These wells consist of pipe,  $\frac{3}{4}$  to 2 in. in diameter, to the end of which is attached a well-point 18 in. to 6 ft. long. This point is imbedded in gravel, poured into the well

at the time it is bored and before the casing is withdrawn. The wells are spaced from 10 to 20 ft. apart, this distance again being governed by local conditions in that particular lake. The wells connect to a sub-header, while the various sub-headers in the system join the main header which is also the pump suction. At present very little is being done toward primary concentration of the brine at the place of pumping, so the brine as taken out of the lake is pumped to the evaporating plant through 4- or 6-in. pipe lines. Six-inch wood pipe is now being used exclusively on account of the scarcity and prohibitive cost of wrought iron pipe. In some instances

the wells in lakes have been pumped several weeks after the bed of the lake was dry. At other times fresh water was pumped in to cover the surface for two reasons: first, to keep the wells sealed so as to prevent air leakage into the main pipe system; and second, to allow this clear water to percolate through the sand bed, collecting in its travel any crystals of soluble salts with which it may come in contact before reaching the well-point.

Evaporation practice used in the Nebraska potash industry is nothing new, most of the companies using Swenson or Devine Evaporators. The Swenson system of evaporation may be readily understood by following the accompanying diagram, Fig. 1.

The potash-bearing water as it comes from the reservoir first enters the condenser where it liquefies the vapors from the third effect, producing in the latter a vacuum, the amount of which is governed largely by the

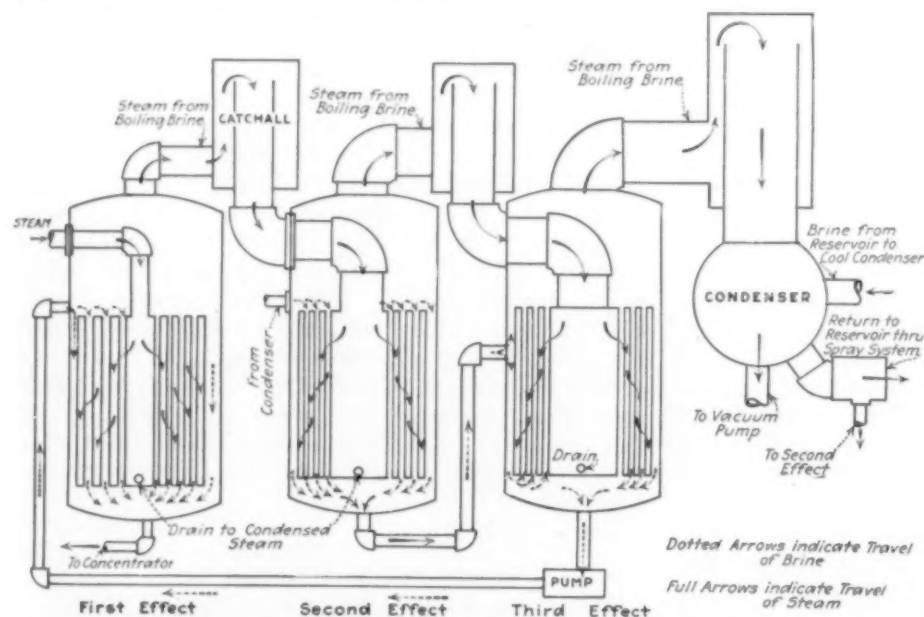


FIG. 1.—SWENSON SYSTEM OF EVAPORATION

various companies are pumping extends over an area of about 330 square miles. Potash has also been found in other lakes outside of this field; possibly the brine waters are scattered over a total area of about 600 square miles.

It has been definitely proved by the continuous pumping of certain lakes that the potash supply of Western Nebraska is not inexhaustible.<sup>2</sup> In fact, the water in the majority of the lakes lowers in density after being pumped for a certain length of time, there being a specific instance where a lake first delivered brine with a density of 10 deg. Bé., while after five months' pumping the density of the brine coming from the same wells was only 2 deg. Bé. Another peculiarity about these lakes is that if they are allowed to "rest" for a certain length of time, the density will increase and in rare instances assume the original specific gravity, only to decrease again after a second pumping. This

<sup>1</sup>See communication from W. A. Norris on this subject in *Metalurgical & Chemical Engineering*, Mar. 15, 1918.

<sup>2</sup>See a description of "The Nebraska Potash Industry," *Metalurgical & Chemical Engineering*, Dec. 15, 1917.

temperature of the boiling brine contained in that cell. During its travel through the condenser the dilute solution naturally becomes hot, and the necessary fraction is taken through the pipe line marked "To second effect." The balance and greater portion of the water is returned to the reservoir through a spray system. The purpose of spraying this water is first to take advantage of the evaporation that will take place when the hot brine is sprayed into the cooler atmosphere, and, second, to keep the temperature of the liquid in the reservoir as low as possible. Brine enters the second effect at about the same density that it comes from the lake; there it is boiled under a vacuum of from 1 to 10 in. and a temperature of from 180 to 200 deg. F. by the heat given up by the vapors formed in the first effect. From the second effect the brine goes to the third effect where it is boiled under a vacuum of 15 to 24 in. and a temperature of from 130 to 150 deg. F. by the heat given up by the vapors formed in the second effect. Finally, from the third effect the concentrated liquor is pumped to the first effect, where it is boiled under a pressure of 4 to 12 pounds and at a temperature of 220 to 240 deg. F. by live steam from the boiler house. The process is a continuous one and is so regulated that the density of the brine in the first effect is raised to 20 deg. Bé. when the contents are pumped into the "concentrator" for further evaporation.

Each cell of the evaporator consists of a steel shell inside of which is a "basket" composed of many 2-in. tubes, the brine being around the basket and the steam inside it. In no case do the brine and the steam come in actual contact with each other. The concentrator, which is not shown in Fig. 1, is similar to a cell of the triple effect evaporator except that it is provided with a circulating pump to keep the brine agitated at all times. This is necessary in order to prevent any separated salts from settling to the bottom, which would invariably happen if the liquid were not kept in constant motion. Live steam is used for heating the solution in the concentrator. The density of the brine is here carried to between 30 and 40 deg. Bé., varying inversely with the amount of soda contained.

The efficiency of the above method of evaporation is constantly being improved by such expedients as placing a heater between the second and third effects, by using the exhaust steam from the concentrator for further boiling and by several other small improvements that will increase the density of the brine in its travel through the system.

Drying the salts has been a hard problem in this region, much money having been spent on various types of dryers while only one has proved at all satisfactory. We are now expectantly awaiting results obtained in a drier under construction by the Western Potash Works at Antioch, which is entirely different from anything ever tried before. The successful dryer in universal use consists of a cylindrical steel shell 30 to 45 ft. long, and 4 to 6 ft. in diameter. The saturated brine as delivered from the concentrator is sprayed into the cylinder at the upper end, and travels toward the fire end. The precipitated salts are thus subjected to the highest heat just before the brine is discharged from the dryer. The shell is provided with inner baffles and rollers to keep the dried salts from adhering to it.

This type of dryer will deliver salts with a moisture content as low as 0.5 per cent, although the most economical point has been found to be around 3 per cent.

The cool end of the dryer is connected to a dust chamber through which the dust and gases pass. Baffles catch the entrained dust quite successfully, and tests of the gases at the top of the stack show very little if any potash when the dryer is running under normal conditions.

Nebraska is now producing about 450 tons of salts daily, with an average potash content of 25 per cent. This production is expected to be further increased in the near future when the latest plant to begin operations comes into its own, and when two others which are now under construction begin operations.

Our potash industry has had its opportunity due to lack of German products. It developed during war times and naturally had to pay war prices for all materials. It had to educate its own labor and make living conditions in the Sand Hills such that it would be possible for families to settle there. It had an uphill fight all the way to prove that it was an essential industry and to get preference on all necessary materials.

A great question in the minds of many people today is whether Nebraska potash can compete with the German product after the war? However, this is not the question that is bothering the people financially interested in the industry. They are more interested in the excess profits section of the revenue bill now in Congress. If the bill does not allow the potash plants to write off their investments in the plants before heavy taxes shall accrue, it will greatly retard the industry; while if they are allowed the amortization of the plants first it will mean its salvation, and would greatly stimulate and promote the somewhat hampered production. Favorable action now would greatly help this new-born American industry to make the United States self-supporting after the war and make us independent of German potash.

Antioch, Nebraska.

### Importation of Copper Ore

The ruling of the War Trade Board (No. 211) affecting the importation of copper ore has been so far modified by a new ruling (W. T. B. R. 249) as to permit the importation of copper concentrates containing 50 per cent or over of copper from non-enemy countries, instead of 60 per cent or over as in the former ruling. The previous restriction prohibiting the importation of ore, except from Cuba, Canada or Mexico, and of copper concentrates containing less than 50 per cent of copper, except from the above countries, remains in force. There is no restriction upon the importation from any non-enemy country of copper matte, blister copper, or copper concentrates containing 50 per cent or more of copper.

### Synthetic Phenol

Attention is called to an error which occurred in the make-up of Mr. Peterkin's article on this subject in our issue for September 1. Titles of Charts I and II were inadvertently reversed.

<sup>2</sup>See "Potash, I. W. W. and the Fuel Administration," *Metalurgical & Chemical Engineering*, Nov. 15, 1917.



## Aluminium and Its Light Alloys—V

**Duralumin Is the Most Remarkable Light Alloy of Aluminium, Resisting Corrosion and Possessing Important Physical Properties—Four Types of Deterioration of Aluminium Alloys**

BY PAUL D. MERICA

### DURALUMIN<sup>1</sup>

THE most remarkable light alloy of aluminium is undoubtedly duralumin, the behavior and properties of which were discovered by Wilm (474) during his investigation during the years from 1903 to 1911. The remarkable feature about it is that, alone among light aluminium alloys, its mechanical properties may be vastly improved by heat treatment.

The composition of this alloy varies somewhat; on the continent the following range of compositions is used:

	Per Cent
Copper .....	3.5 — 5.5
Magnesium .....	0.5
Manganese .....	0.5—0.8
Aluminium .....	balance

It is thus an alloy which can readily be rolled or forged; indeed it is always used in this condition, since the development of its highest physical properties involves the application of mechanical work to it.

The electrical resistivity of annealed duralumin is 3.43 microhm-cm.; in the heat-treated condition, however, in which it is always used, the resistivity is much higher, being 4.73 microhm-cm. In this condition it has approximately 35 per cent of the volume-conductivity of copper.

The density of duralumin varies from 2.75 to 2.84; its melting point is about 650 deg. C.

When this alloy is heated for a few minutes at temperatures from 400 to 520 deg. C. and quenched in water the hardness is very little increased over that which would be obtained by slowly cooling the same alloy. But upon aging the quenched alloy for several days at ordinary temperature both the hardness and the ductility are increased from 15 to 50 per cent, depending on the composition of the alloy and the quenching temperature. Thus an alloy showed the following changes of properties:

	After rolling, before hardening.	After hardening, quenching and aging.
Tensile strength, lb. per sq.in. ....	37,000	58,000
Elongation, per cent ....	17	23

The change of hardness during aging is shown in Fig. 22.

After hardening this alloy by quenching and aging, it may be still further hardened by cold work, at the cost, of course, of ductility. The curves, Fig. 23, show the increase of tensile strength and decrease of ductility that occur when both annealed and hardened duralumin are cold-worked.

The hardness produced by hardening is of course

TABLE XVIII.  
TENSILE PROPERTIES OF DURENER DURALUMIN

Cohn (473, 476)				
Treatment	Yield Point, Lb. per Sq. In.	Tensile Strength, Lb. per Sq. In.	Elonga- tion in 2 In., Per Cent	Reduction of Area, Per Cent
Alloy H, Density 2.75				
Soft—7 mm. ....	27,000	51,200	25.0	34.0
Rollled to 6 mm. ....	.....	54,000	10.0	22.0
Rollled to 5 mm. ....	.....	59,800	6.3	18.0
Rollled to 4 mm. ....	.....	61,900	5.0	13.0
Rollled to 3 mm. ....	.....	64,800	5.0	14.0
Rollled to 2 mm. ....	.....	67,500	4.0	12.0
Alloy 681-B				
Soft—7 mm. ....	40,000	62,800	17.6	21.7
Rollled to 6 mm. ....	67,000	71,100	8.0	16.3
Rollled to 5 mm. ....	.....	75,000	5.3	12.7
Rollled to 4 mm. ....	.....	78,300	4.0	9.7
Rollled to 3 mm. ....	.....	80,500	3.4	7.3
Rollled to 2 mm. ....	.....	83,200	2.5	6.6
Alloy 681-D, Density 2.83				
Soft—7 mm. ....	36,900	65,300	17.5	21.0
Rollled to 6 mm. ....	58,600	74,200	8.6	18.0
Rollled to 5 mm. ....	64,200	78,500	6.6	15.0
Rollled to 4 mm. ....	.....	.....	.....	.....
Rollled to 3 mm. ....	75,400	84,000	4.6	11.0
Rollled to 2 mm. ....	77,000	88,300	3.0	11.0
Alloy 681-A, Density 2.79				
Soft—7 mm. ....	35,100	59,500	21.1	29.5
Rollled to 6 mm. ....	65,900	67,700	9.0	21.5
Rollled to 5 mm. ....	.....	.....	.....	.....
Rollled to 4 mm. ....	69,200	75,000	5.0	14.5
Rollled to 3 mm. ....	.....	.....	.....	.....
Rollled to 2 mm. ....	75,400	79,600	4.0	13.2
Alloy 681-C.				
Soft—7 mm. ....	40,600	64,200	17.6	22.0
Rollled to 6 mm. ....	67,800	73,200	7.4	14.5
Rollled to 5 mm. ....	.....	76,800	5.2	12.5
Rollled to 4 mm. ....	.....	80,000	4.5	8.7
Rollled to 3 mm. ....	.....	82,500	3.5	8.0
Rollled to 2 mm. ....	.....	85,800	3.1	6.3

lost upon annealing at rather low temperatures. The curves of Fig. 24 show the effect of annealing at different temperatures followed by air-cooling, upon the hardness and ductility of a hardened duralumin. It is noticed that duralumin hardens slightly even when cooled in air.

Duralumin loses its hardness at higher temperatures. Fig. 25 shows the effect of higher temperatures upon the hardness of this alloy.

Table XIX gives the results of a number of tests of commercial duralumin from the Dürer Metallwerke A. G.

TABLE XIX—EFFECT OF 14 MONTHS' IMMERSION OF DURALUMIN IN DIFFERENT SOLUTIONS. COHN (471, 473)

Solution	Concentration	Decrease in Thickness, mm.	Description of Sample
HCl	1/10 u	0.28	{ Samples were all attacked with pits and holes.
	1/5 u	0.25	
	1 u	2.05	
HNO <sub>3</sub>	1/10 u	1.75	Attack uniform.
	1/5 u	0.45	Attack uniform.
	1 u	0.10	Attack uniform.
Acetic	50%	0.03 to 0.05	Attack uniform except where at surface exposed to acid and air.
	80%	0.03 to 0.10	
H <sub>2</sub> SO <sub>4</sub>	1/10 u	0.20 to 0.25	Attack uniform.
	1/5 u	0.38	
	1 u	0.85	
NH <sub>4</sub> OH	50%	0.13 to 0.35	Gray layer, attack uniform.
Acid vapors	Concentrated in hood of laboratory	0.11 to 0.13	Uniform attack.
HgCl <sub>2</sub>	.....	0.5 to 0.75	Material attacked but not brittle.
Hg	.....	0.00	No action.

<sup>1</sup>Most of the data in the paragraphs on duralumin have been taken from articles by Cohn (471, 473, 476).

Duralumin<sup>1</sup> when heat treated and cold worked to give about 6 per cent elongation in 2 in. corresponding to a yield point above 35,000 lb. per sq.in., will withstand unlimited alternations of stress between 0 and 20,000 lb. per sq.in. tension.

**Corrosion.** Duralumin in the hardened condition is remarkably resistant to corrosion, considering that it contains much copper which is recognized to be usually a harmful constituent of an aluminium alloy from the standpoint of corrosion. This fact is particularly important in view of the use of the alloy for construction

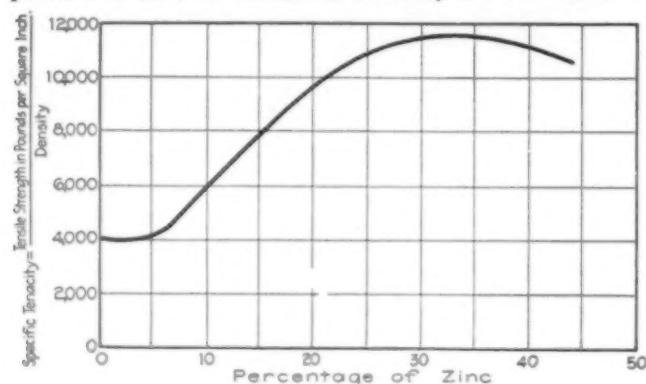


FIG. 22

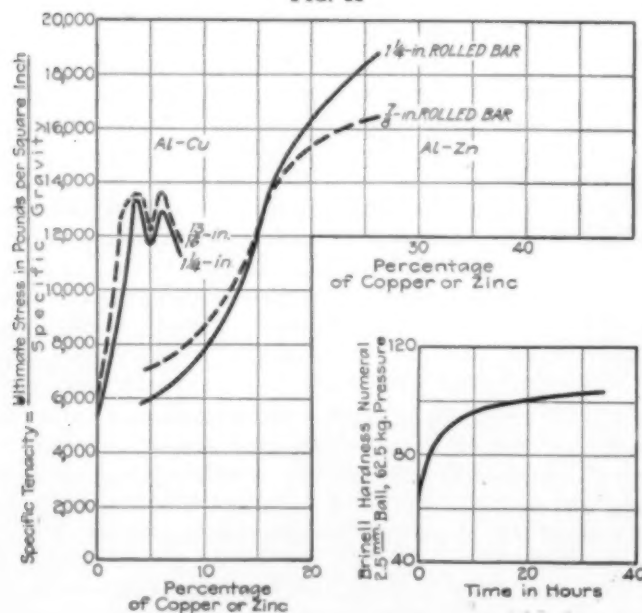


FIG. 23

FIG. 24

Fig. 22—Specific Tensile Strength of Sand-Cast Zinc-Aluminum Alloys (Rosenhain and Archbutt, 438).

Fig. 23—Comparison of Specific Tensile Strengths of Rolled Al-Zn and Al-Cu Alloys (Rosenhain and Archbutt, 438).

Fig. 24—Increase of Hardness of Duralumin Upon Ageing After Quenching (Cohn, 471, 473).

where it will be subject to weathering and corrosion.

The Dürener Metallwerke A. G. have made extensive investigation of this feature. Sheets 2.35 mm. thick were immersed for 14 months in several solutions and the decrease in thickness measured as well as appearance observed after that time. Table XIX gives the principal results of these tests.

A mixture of concentrated  $H_2SO_4$  and  $HNO_3$  scarcely attacks duralumin, nor does concentrated  $H_2SO_4$  containing some dissolved  $K_2Cr_2O_7$ ; the latter is recommended as a cleansing solution for duralumin vessels.

<sup>1</sup>Private communication from The Aluminum Castings Company, through Prof. Jeffries.

Some tests made at the shipbuilding docks of Vickers Ltd., Barrow-in-Furness, indicate that duralumin in the hardened condition resists the action of sea-water very well indeed. Four strips, one foot square, were hung on the ways such that at low tide they were above the water level, at high tide, immersed. After six months the losses in weight and thickness were as follows:

No.	Loss in Weight Gram per Sq. Cm.	Loss in Thickness in Cm.
1.....	0.00103	0.00038
2.....	0.00107	0.00039
3.....	0.00045	0.00016
4.....	0.00062	0.00023

The Luftschiffbau-Zeppelin-Gesellschaft exposed angles and U-profiles of duralumin, copper, iron, aluminium alloys, pure aluminium, and elektron to the action of sea air and spray on a light-ship in the North Sea for three months. These sections were also riveted and screwed together. Duralumin resisted these conditions

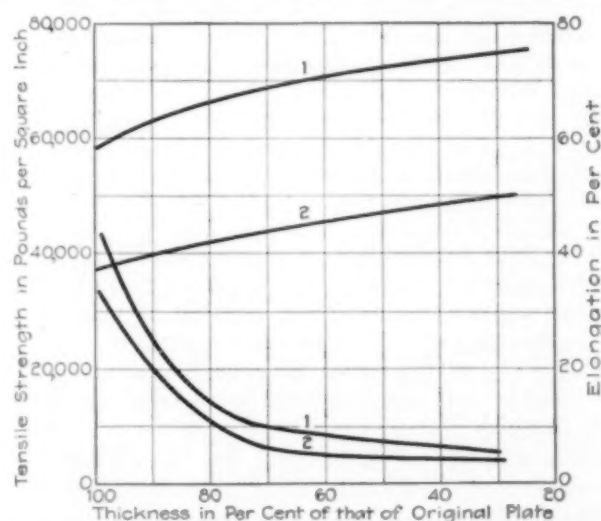


Fig. 25—Increase of Hardness of Duralumin by Cold Working (Cohn, 471, 473). 1. Tensile Strength and Elongation of Hardened Duralumin. 2. Same for Rolled But Not Hardened

better than any of the other materials (Cohn—*loc. cit.*), and showed practically no oxidation.

Investigation has also been made of the alteration in mechanical properties of duralumin brought about by exposure to corrosion. It is known that some alloys of aluminium and aluminium itself often suffer deterioration in this manner. The Dürener-Metallwerke A. G. exposed bars and wire of different sizes of duralumin on the roof of one of their buildings for two and one-half years. Samples were tested from time to time and within that period no evidence of any alteration in hardness or ductility was shown. Evidently the properties of this material acquired by hardening are quite stable.

There are described below some tests on the stability of aluminium alloys, including duralumin when tested in a corroding medium.

From the foregoing paragraphs it is seen that duralumin has been subjected to rather extensive and severe tests covering its properties and their stability under different conditions. It is apparently a most excellent material for construction purposes, for the production of structural members, for forgings and for tubes, bars and wire.

It is possible to weld duralumin in the same manner as pure aluminium. The joint is not as strong as the



TABLE—XX TENSILE PROPERTIES OF DURALUMIN

Form	Tensile Test		
	Tensile Strength, Lb. per Sq. In.	Yield Point, Lb. per Sq. In.	Elongation in 7 in. Per Cent
Sheet.....	55,000	25,000	15
	50,000	25,000	20
Tubes.....	55,000	35,000	12
	50,000	25,000	20
Bars:			
1 to 1 in.....	55,000	25,000	15
1 to 2 in.....	50,000	25,000	15
2 in. and above.....	45,000	20,000	15

original material, however, since the heat of welding destroys the properties produced therein by hardening. By cooling the joint rapidly after welding some improvement may be made. For the present therefore construction work with duralumin may best be done by riveting or other mechanical forms of jointing work.

In table XX are given the physical properties which may usually be obtained for duralumin in different forms.

## MISCELLANEOUS ALLOYS

In the foregoing paragraphs have been described those alloys which have been used commercially to some extent. There are described in the patent and periodical literature almost as many light aluminium alloys as there have been investigators interested in them, and it would be useless to attempt to enumerate all of them. In table XXI however is given a list of many of them, together with whatever information is known about them. The numerical values given in this table are merely those published and are not guaranteed.

A list of patents covering light aluminium alloys, complete for the United States and incomplete for other countries, is given in Table XXII.

The alloys of magnalium have been studied by Mach (Krause, p. 107).

The alloys of aluminium, zinc and magnesium have been studied by Murmann (Krause, p. 108).

D. R. Patent 231,060, 1909, describes the properties of alloys of aluminium, copper, manganese and silver.

D. R. Patent 242,313, 1911, describes the properties of alloys of aluminium with cobalt and tungsten.

Rübel (Krause, p. 129) describes the properties of alloys of aluminium with phosphorus.

Borchers (Krause, p. 130) describes the properties of aluminium to which cerium has been added. This metal is a good deoxidizer and fluxes for aluminium, and is said to reduce its content of silicon.

Uyeno (Krause, p. 132) describes alloys of aluminium with mercury and zinc which are used to generate hydrogen (with hot water) for balloons.

## X. PHYSICAL PROPERTIES OF LIGHT ALLOYS

Besides the usual mechanical properties of alloys, the engineer (particularly the aircraft engineer) is interested in (1) the effect of temperature on the mechanical properties of the light alloys, and (2) the thermal conductivity of casting alloys (motor pistons).

Besides the tests by Rosenhain and Archbutt on aluminium-zinc alloys (438), some of which are described above, and those on duralumin by Cohn (476), (described above), no results of tensile tests of light alloys at high temperature have been published. In general, however, a light alloy to withstand high temperatures should be made with a metal or metals of high melting point, such as iron, manganese, or nickel. An alloy contain-

Tensile Properties										Elongation, Per Cent	Reduction of Area, Per Cent	Notes
Tensile Strength, Lb. per Sq. in.	Yield Point, Lb. per Sq. in.											
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	{ Used by Carl Zeiss for light instru- ment parts—is readily ma- chined.	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	McAdams Aluminum Co. The Aleral Co. of America. The Aleral Co. of America. The Aleral Co. of America. The Aleral Co. of America. Walker M. Levett Co. Prett, Bowley & Co. Chemische-Fabrik Griesheim- Elektron. Richard Weidner. { By Fletcher and Emperer. Krupp. Bensch, used for machine castings Le Ferro-Nickel. Krupp-alloy is hard and can be worked. Otto-Gruen & Co.	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	.....	.....	.....				

TABLE XXI—MISCELLANEOUS LIGHT ALLOYS

Name of Alloy	Per Cent Composition					
	Al	Cu	Zn	Mg	Mn	Ni
Weldrium.....	60 (T)	.....	40 (T)	.....	.....	.....
Zialon.....	85 (T)	.....	15 (T)	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
Magnalium X.....	.....	1.76	.....	1.60	.....	1.16
Magnalium Y.....	.....	.....	.....	.....	.....	.....
Magnalium Z.....	.....	0.21	.....	1.38	.....	.....
McAdamsium.....	.....	3.2	12-18	0.2	.....	.....
Aleral.....	.....	.....	.....	.....	.....	.....
Sheet A.....	.....	2.3	.....	0.1	1.5	.....
Sheet B.....	.....	2.4	.....	1.2	.....	.....
Sheet C.....	.....	3.7	.....	0.3	1.0	.....
Sheet D.....	.....	3.8	.....	0.5	1.0	.....
Cast.....	.....	6.4	0.4	.....	.....	0.9
Magnalito.....	93.4	2.5	0.5	1.3	.....	1.5
Zimalium.....	.....	.....	3-4	3-7	.....	.....
Alerium.....	.....	.....	.....	.....	.....	.....
Elektrometall.....	.....	.....	.....	.....	.....	.....
Weldrium.....	Contains Ni, Cu, Zn or Sn, Fe, Mg	.....	.....	.....	.....	.....
Bearing metal.....	95.5	3	.....	.....	.....	.....
Bearing metal.....	92.2	7.5	.....	.....	.....	.....
Bearing metal.....	87	8	.....	.....	.....	.....
.....	93	.....	.....	.....	.....	7
.....	94-98	1.5-4	.....	.....	0.25-1.25	.....
Thors-argent.....	.....	.....	.....	.....	.....	.....
.....	66	.....	.....	.....	.....	.....
Albidur-aluminium.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....		

(p)—Proportional limit. B. S.—Bureau of Standards test.

TABLE XXII—LIST OF PATENTS COVERING LIGHT ALUMINIUM ALLOYS

U. S.	Date	U. S.	Date	U. S.	Date	German	Date
44,086	1864	1,104,369	1914	699,216	1902	144,777	
632,743	1899	1,121,269	....	662,952	1900	113,935	1899
652,833	1900	1,117,308	....	639,600	1899	119,643	....
867,194	1907	1,121,268	....	646,442	1900	125,334	....
451,406	1891	1,121,267	....	662,951	....	204,543	1907
684,207	1901	1,080,155	1913	639,084	1899	244,554	....
1,212,374	1917	1,076,137	....	611,016	1896	112,546	1899
1,227,174	....	1,072,017	....	580,711	1897	170,085	1903
1,224,362	....	1,080,158	....	501,553	1893	218,970	....
1,175,655	1916	995,113	1911	480,445	1892	230,095	1909
1,146,185	1915	886,597	1908	451,405	1891	231,060	1909
1,130,785	....	856,392	1907	446,351	1891	243,313	1911
1,092,500	1914	759,617	1904	443,943	1890	137,003	....
1,095,653	....	721,814	1903	373,231	1887	134,582	....
1,099,561	....	743,566	1903	320,149	1879	268,515	....
1,102,618	....	697,544	1902	38,301	1862	203,557	1906
.....	.....	.....	.....	.....	.....	257,868	1911

ing somewhat more copper than No. 12 is manufactured by the Aluminum Castings Co. for service at elevated temperatures, for pistons etc. Much information covering both topics mentioned above is to be found in recent confidential military reports.

The alloys of magnesium and aluminium have attained some recognition as suitable for large optical mirrors. Mach and Schumann (290) have studied the adaptability of these alloys for this purpose and find that the alloy containing the compound  $Mg_2Al$  is the best of the series. It is hard, and when polished has a reflecting power equal to or better than a silvered glass mirror. Special precautions must be taken to prevent the formation of blowholes; this is done by melting under a flux of salts, preventing the absorption of gas.

#### XI. CORROSION, DISINTEGRATION AND DETERIORATION OF ALUMINIUM AND ITS ALLOYS

The subject of the deterioration of aluminium and its alloys in service has naturally been of the greatest interest to the metallurgist and engineer alike; unfortunately it must be admitted that insufficient investigation has been made of the various rather obscure phases of it that some of the observed phenomena may be regarded as in any sense solved.

It may be preferable to distinguish four types of deterioration of aluminium alloys.

**Corrosion.** The corrosion, uniform or local, of the metal and its alloys is discussed above insofar as it has been investigated. An adequate direct comparison of the corrodibility of the various commercial casting alloys has never been made, although such information would be quite valuable, particularly to airplane designers and naval architects.

The following table gives an approximate comparison of the behavior of different alloys in sea water:

	Loss of Weight in Sea Water Lb. per Sq. Ft. per Month
Rolled aluminium-copper alloys; 0 to 8 per cent Cu	0.008 - 0.003
Chill cast aluminium-copper-manganese alloys....	0.0004
Sand cast aluminium-zinc alloys.....	0.001 - 0.002
Duralumin sheets.....	0.0009 - 0.002
Muntz metal.....	0.0023
Naval brass.....	0.0012
Mild steel.....	0.0022

When it is considered that the loss of volume of the light alloys per unit loss of weight is about 2.8 times that of brass or steel it is realized that particularly the copper and the zinc alloys cannot be used in sea water without some protective coating. The corrosion of alloys is in many cases not such a serious matter as they may be effectively protected from corrosion in most cases by a varnish or paint.

**Cracking.** Many cases of mysterious cracking of aluminium alloy castings, particularly of the zinc-

aluminium type, are undoubtedly due to shrinkage cracks originating during the solidification of the casting. It is well known that all aluminium alloys are fragile at temperatures just below the melting point or range; cracking due to faulty moulding or hard ramming is generally visible in the finished castings, but invisible and interior cracks are often formed which open up subsequently when stress is applied. The remedy for such defects lies of course only in better foundry and casting designing practice and in the use of alloys of least fragility at these temperatures. It is the consensus of opinion of foundrymen that zinc-aluminium alloys are inferior to aluminium-copper alloys in this respect. The addition of copper to alloys containing zinc materially improves this condition.

**Disintegration.** The spontaneous disintegration of alloys of aluminium with high percentages (50 per cent and more) of iron, manganese, nickel has been noted by investigators (Hindricks). These alloys when cast are hard and brittle but upon standing actually fall to powder.

The same type of phenomenon is observed in the case of aluminium-zinc alloys containing 50 per cent zinc and more (Pack, 302, Williams, 295). Such alloys annealed after casting are sound and dense, but upon standing (under no stress) particularly when exposed to slightly higher temperatures and moist air, swell and warp; cracks appear in the castings.

The final explanation of these changes has not been given; in fact the data are still discordant. Rosenhain and Archbutt (see above) found no evidence whatever of deterioration within ten months in sand-cast aluminium-zinc alloys containing up to 75 per cent of zinc. The changes which occur are due probably either to some change in constitution progressing in the alloy, or to differences in the coefficients of thermal expansion of the different constituents of the alloy. These changes have also been somewhat vaguely ascribed to the presence of impurity in the alloy (see discussion on Rosenhain-Archbutt paper, 438).

**Corrosion and Stress.** Under this group are considered some very interesting cases of deterioration due to the combined effect of stress and corrosion.

The experiments of Heyn and Bauer (130) have been described above, in which it was found that cold-rolled or hard aluminium sheet is exfoliated and blistered badly during corrosion in certain solutions, whereas the same material, annealed, corrodes quite uniformly in the same solutions. The effects of initial stress on the electrolytic solution of the metal and of the relief of initial stress by corrosion combine to produce this unusual phenomenon.

Somewhat more recently investigation has disclosed the fact that the tensile properties of hard drawn bars of an aluminium-zinc-copper alloy are very unfavorably affected by simultaneous corrosion (Cohn, 476). His results, obtained on an alloy of the following composition:

	Per Cent
Zinc .....	9.40
Copper .....	0.32
Magnesium .....	0.39
Aluminium .....	balance

in the form of extruded (?) bars are given in Table XXIII.

It is noted that in the hard or cold-worked condition the alloy gave a much less ductility and strength when



TABLE XXIII—EFFECT OF STRESS AND CORROSION ON TENSILE PROPERTIES OF ALUMINIUM ALLOYS  
(Cohn, 471,473)

Alloy	Temperature of Tensile Test and Medium in Which Test Was Made, Deg. C.	Description of Test Condition	Tensile Strength, Lb. per Sq. In.	Elongation in 2 in., Per Cent	Remarks
Extruded (and drawn?), alloy Per cent Zn—9.40 Cu—0.32 Mg—0.39	0—ice water..	Tested as noted in (column 2).....	45,300	16.0	Some fine cracks.
	20—air.....	Tested as noted in (column 2).....	45,900	16.1	Many cracks.
	20—water.....	Held in water at 70 deg. for 1 hour in contact with iron, tested (column 2).....	45,000	15.3	Specimen covered with cracks.
	70—water.....	Held in water at 20 deg. for 2 hours in contact with iron before testing (column 2).....	38,500	6.4	(1) Specimen covered with cracks.
	70—water.....	Held in water at 70 deg. for 1 hour, tested (column 2).....	33,000	5-6	Specimen covered with cracks.
	70—water.....	Held in water at 70 deg. for 1 hour, tested (column 2).....	37,000	(1)	Specimen covered with cracks.
Above alloy annealed at 400 deg. C.	0—ice water..	Held in water at 70 deg. for 1 hour, tested (column 2).....	31,600	4.2	Specimen covered with cracks.
	20—air.....	Held in oil at 70 deg. for 1 hour, tested (column 2).....	40,000	11.5	Some fine cracks.
	70—water.....				
Duralumin heat-treated	0—ice water..		44,000	21.1	
	20—air.....		42,600	20.8	
	70—water.....		35,800	17.4	
Duralumin heat-treated and cold worked	0—ice water..		64,400	20.0	
	20—air.....		62,400	20.0	
	70—water.....		60,000	20.0	
	0—ice water..	Held in water for 3 hours, in contact with iron, tested (column 2).....	75,300	6.9	
	20—air.....		76,000	6.1	
	20—water.....		75,100	6.9	
	70—water.....		72,800	5.5	

(1) Broke outside of gage length.

tested in water than when in air. After annealing this effect was reduced. Duralumin showed practically no sensitivity to such treatment either as heat-treated or as heat-treated and cold worked.

These experiments were undertaken in order to explain the cracking which had been noticed of sections, rods and tubes of this commercially much used alloy when stored and under no stress. Similar experience has been recorded in the case of the breaking and em-

both steel and wood in construction in which both strength and lightness are a prime requisite.

### XIII. HEAVY ALUMINIUM ALLOYS

The use of aluminium as an alloying element is perhaps as extensive in alloys containing an excess of other metals as in the light alloys.

Alloys of from 3 to 10 per cent of aluminium in copper are manufactured in both the cast and in the rolled

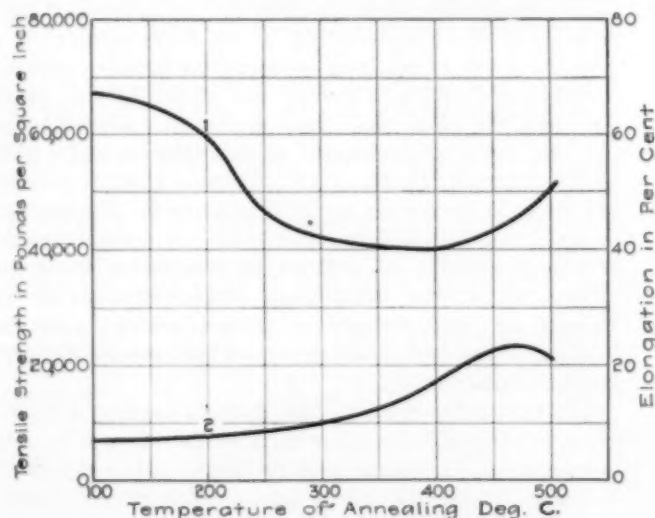


Fig. 26—Effect of Annealing Duralumin (Cohn, 471, 473). 1. Tensile Strength; 2. Elongation. Sample Annealed and Cooled in Air

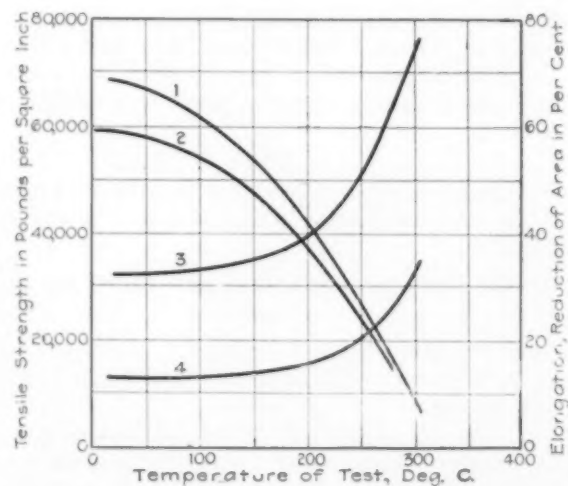


Fig. 27—Effect of Temperature on Physical Properties of Duralumin (Cohn, 471, 473). 1. Tensile Strength; 2. Yield Point; 3. Reduction of Area; 4. Elongation.

brittling of hard-drawn aluminium wire electric conductors.

### XII. COMPARISON OF DENSITY AND MECHANICAL PROPERTIES OF ALUMINIUM ALLOYS WITH OTHER MATERIAL OF CONSTRUCTION

In Table XXIV are compared the tensile properties for several materials used for construction in relation to their densities. Steels have been chosen for comparison which have approximately the same ductility as the duralumin. Douglas fir has been included as representing the best wood available for aircraft wood construction. The values given bring out the fact that, weight for weight, duralumin and similar light alloys are as strong as the best steels and for the same strength give greater stiffness. There appears to be no doubt of the adequacy of such light alloys as substitutes for

or wrought form under the name of aluminium bronzes. The properties of these alloys are described by Corse and Comstock (478), Corse (482), Read (490), Carpenter and Edwards (380), and many others.

An aluminium bronze containing 10 per cent of aluminium will have the following tensile properties when cast to size (478):

Tensile strength, lb. per sq.in.....75,000  
Elongation in 2 in., per cent..... 24

A modification of this alloy containing 10 per cent of iron, 10 per cent of aluminium and treated with titanium will give the following tensile properties when cast to size:

Tensile strength, lb. per sq.in.....80,000  
Elongation in 2 in. per cent..... 30

Aluminium bronze for rolling containing usually

\*Private communication from Mr. W. M. Corse.

TABLE XXIV—COMPARISON OF MECHANICAL PROPERTIES OF SOME MATERIALS OF CONSTRUCTION

Material	Tensile Test										Ratio of weight, diameter and transverse stiffness of a round bar of duralumin having same working load to that of a similar unit bar of material opposite			
	Density, gr. per cu.cm.	Modulus of Elasticity, lb. per sq.in.	Tensile Strength, lb. per sq.in.	Yield Point, lb. per sq.in.	Elongation in 2 in., Per Cent.	Reduction of Area, Per Cent.	Working Stress, lb. per sq.in.	Ratio = Tensile Strength		Ratio = Working Stress		Ratio Weight	Ratio Diameter	Ratio Stiffness
								Density	Ratio = Tensile Strength	Density	Ratio = Working Stress			
Heat-treated alloy steel.....	7.80	$30 \times 10^6$	115,000	115,000	14	45	55,000 (2)	19,200	7.100	1.35	1.92	4.45		
Rolled alloy steel sheet.....	7.80	$30 \times 10^6$	100,000	75,000	20	..	37,000 (2)	12,800	4,700	0.89	1.57	2.05		
Rolled carbon steel sheet.....	7.80	$30 \times 10^6$	75,000	45,000	25	..	23,000 (2)	9,600	2,900	0.55	1.24	0.78		
Rolled and heat-treated duralumin.....	2.85	$10 \times 10^6$	60,000	30,000	15	..	15,000 (2)	21,000	5,300	1.00	1.00	1.00		
Rolled zinc-aluminium-copper alloy (I) (a).....	3.29	$9 \times 10^6$ (7)	71,000	61,000	21	38	30,000 (2)	21,500	9,100	1.71	1.41	1.33		
(b).....	3.29	$9 \times 10^6$ (7)	52,400	36,000	18	..	18,000	15,900	5,400	1.02	1.10	0.48		
Douglas fir (4).....	0.47	$1.64 \times 10^6$	6,100 (3)	4,400	..	..	1,200 (3)	13,000	2,500	0.47	0.89	21.10		

(1) Containing 25 per cent Zn, 3 per cent Cu, (a) in form of  $\frac{1}{2}$ -in. hot-rolled bar (Rosenhain-Archbutt annealed), (b) as rolled 0.156 in. diameter sheet,

(2) Using working stress of  $\frac{\text{yield stress}}{2}$

(3) Adopted by American Railway Engineering Association.

(4) These values are determined in the transversal bending test.

about 7.5 per cent of aluminium. This alloy when rolled will give the following approximate values of the tensile properties:

Tensile strength, lb. per sq. in. . . . . 80,000–90,000  
Yield point, lb. per sq. in. . . . . 15,000–20,000  
Elongation in 2 in., per cent. . . . . 20–30

Aluminium is extensively used as a deoxidizer in both iron, steel and non-ferrous metals, and also in the manufacture of steel to produce blowhole-free ingots of steel. Brinell (479) finds that this effect of aluminium preventing blowhole formation in acid-steel ingots is about 18 times as great as that of silicon and about 90 times as great as that of manganese. He gives the formula

$$D = Mn + 5.2 Si + 90 Al.$$

If  $D = 2$ , blow-hole-free acid steel ingots are produced 24 by 24 cm. when poured into an almost cold iron mold, 5 cm. thick.

#### XIV. SPECIFICATIONS FOR ALUMINIUM AND ITS LIGHT ALLOYS

There are given below references to published specifications for commercial aluminium and its light alloys.

##### A. Aluminium.

(a) Ingot aluminium, U. S. Navy Department, No. 47A1a, 1915. International Aircraft Standards Board, No. 2N1, 1917.

(b) Aluminium sheet, International Aircraft Standards Board, No. 3N12, 1917.

(c) Aluminium bars, International Aircraft Standards Board, No. 3N23, 1918.

(d) Aluminium tubes, International Aircraft Standards Board, No. 3N20, 1917.

##### B. Aluminium Alloys.

(e) No. 12 casting alloy, Society of Automotive Engineers, No. 30, 1912. International Aircraft Standards Board, No. 3N11, 1917.

(f) No. 31 casting alloy, Society of Automotive Engineers, No. 31, 1912.

(g) Casting alloy, U. S. Navy Department, No. 49A1, 1915.

(h) Duralumin sheet, International Aircraft Standards Board, No. 3N16, 1917.

(i) Duralumin bars, International Aircraft Standards Board, No. 3N18, 1918.

(j) Duralumin tubes, International Aircraft Standards Board, No. 3N17, 1918.

### Thick Deposit of Electrolytic Nickel

Among the interesting exhibits at the recent Chemical Exposition was one which should have been marked with the "bull's eye" to indicate that it represented manufacture since the war. This comprised a number of shapes of pure electrolytic nickel which had been deposited on molds to a thickness of as much as one-eighth inch. Heretofore electroplaters had considered it impossible to make satisfactory nickel plate thicker than 0.001 to 0.002 of an inch in thickness because heavier plates were brittle and porous and tended to scale from the metal on which they were deposited. According to the new process represented in the exhibit, and which is the invention of Mr. C. P. Madsen, a dense deposit can be made practically as thick as desired. The process is an excellent example of the art of galvanoplasty, or the production of articles by electrodeposition on molds, which has been used rather extensively in Europe for manufacture of copper articles such as tubing. It has not found extensive commercial development in this country.

The nickel deposited by the Madsen process is homogeneous and malleable, showing a surface free from pits or roughness. In its physical properties it is comparable to rolled nickel, having a tensile strength of 62,000 pounds per square inch with an elongation of 20 per cent. It is impervious even at a pressure of 850 pounds per square inch when the wall of the vessel is but 20/100 of an inch thick. The nickel can be deposited in forms which are now spun or drawn, but more particularly in intricate forms which it is not possible to make by any other known means. Its cost is low because forms can be deposited direct from an impure anode or even from salts in solution. The cost for articles that can be spun is less than by the spinning process on account of the high cost of preparing sheets for the latter method. Since the Madsen nickel has a purity of 99.8 per cent it possesses valuable properties for chemical purposes. On account of the military value of the process it is impossible to give many details but it is the desire of the Government that some publicity should be given to the matter in order that those who might make use of it will know of its existence. Correspondence can be directed to Dr. F. G. Cottrell of the Bureau of Mines, Washington, D. C., and Mr. C. P. Madsen, 44 Walnut St., Newark, N. J.



## Personal

MR. A. W. AMBROSE, acting chief petroleum technologist of the U. S. Bureau of Mines, is spending a few weeks in California on investigations in connection with the work of the Bureau. MR. C. H. BEAL, petroleum technologist of the Bureau, is taking Mr. Ambrose's place during his absence from Washington.

MR. HARRY L. BARNITZ, formerly sales agent for the International Oxygen Company, has severed his connection with that firm and is engaged in consulting engineering in matters relating to oxygen and hydrogen.

MR. A. E. DRUCKER is now connected with the firm of Howard Morinni & Co., Inc., at 111 Broadway, New York City, as manager of their chemical and metallurgical departments.

MR. FRANK P. FAHY, consulting magnetic engineer, Hudson Terminal Building, New York City, has been awarded the John Scott Legacy medal and premium for the development of the Fahy permeameter, by the City of Philadelphia, which acted upon the recommendation of the Franklin Institute.

MR. CLAUDE FERGUSON has resigned as superintendent for the Copper Queen Gold Mining Co., at Stoddard, Arizona, to accept a similar position with the Consolidated Arizona Smelting Co., in charge of the operation of the De Soto and Swastika mines.

PROF. V. H. GOTTSCHALK, formerly professor of chemistry at the Missouri School of Mines and Metallurgy, has been appointed director of pure research for the American Cotton Oil Co. and subsidiaries. His headquarters are at Chicago.

MR. WILLIAM H. HAMPTON has been placed in charge of and development of miscellaneous gas defense apparatus under Major Waldemar Kops, Das Defense Division, Chemical Warfare Service, U. S. A., Long Island City.

MR. W. W. JONES, formerly manager of the New York office of Frederick Stearns & Company, has accepted the appointment of manager of the essential oil and gum department of the National Aniline & Chemical Company, Inc., 21 Burling Slip, New York.

MR. R. V. MILLS, petroleum technologist of the U. S. Bureau of Mines, with headquarters in San Francisco, is at present in West Virginia where he will be engaged in Bureau work for several months.

MR. C. C. O'LOUGHLIN, formerly with Braum-Knecht-Heimann of San Francisco, has joined the sales force of the Hoskins Mfg. Company of Detroit.

DR. E. C. SHOREY has resigned from the Division of Chemical Investigation in the Bureau of Soils, U. S. Department of Agriculture, to accept a position at the Marcus Hook, Pa., plant of the National Aniline and Chemical Co.

MR. H. E. SHRIVER, has accepted a position as chemical engineer with the Air Nitrates Corporation at their electrochemical plant at Muscle Shoals, Ala., in a supervisory position in Unit 5. He was formerly assistant chemist, South Carolina Experiment Station, Clemson College, S. C.

MR. PAYNE G. WEST has been appointed assistant manager of field sales for the Lakewood Engineering Company of Cleveland. He was formerly associated with the T. L. Smith Co., Milwaukee, as sales manager.

MR. O. L. THOMAS is now at the U. S. Government powder plant at Jacksonville, Tenn., as chief supervisor of caustic soda manufacture and soda ash recovery, having been transferred from the Experimental Station of E. I. duPont de Nemours & Co., Wilmington, Del.

## Book Reviews

**CRUDE RUBBER AND COMPOUNDING INGREDIENTS.** A text book of Rubber Manufacture. By Henry C. Pearson, Editor of the *India Rubber World*. Third Edition, 1918. New York: The India Rubber Publishing Co. Price \$10.00.

A practical book of information on rubber manufacture written by a practical man for the benefit of men actively engaged in the production of rubber goods. It can hardly be classed as a scientific work, nor is it aimed at the rubber chemist though he may get many valuable ideas from it. The book is well written and is readily understandable by any one with ordinary intelligence. It includes many old and time-tried ideas, some of which have been found unworkable, but on the whole it teems with suggestions for the man who faces the every-day problems of rubber production and research.

The following is a brief review of its contents:

**CHAPT. I.** Deals with the nature of rubber, botany of the various rubber vines and trees, and gives the origin of many commercial varieties. Both the wild and plantation rubbers are briefly covered. The writer emphasizes a fact often lost sight of which is the most characteristic if not the most important property of rubber, i.e., "it can be repeatedly stretched to many times its length, returning each time to about its first dimensions." He still holds to the old fashioned idea that rubber is composed of an adhesive principle which is readily soluble and a nervy insoluble substance which gives rubber its elasticity. Most modern rubber chemists believe that rubber exists in different degrees of polymerization and that there is no such thing as a soluble and an insoluble portion. It is to be regretted that no analytical data are given for the different rubbers.

**CHAPT. II.** Contains a rather good description, botanically and chemically, of some little known rubbers and pseudo gums; particularly interesting to one working with adhesive problems.

**CHAPT. III.** Deals with methods of coagulation. A brief review of the steps in coagulation and many different processes which have been advanced at one time or another.

**CHAPT. IV.** Vulcanizing processes, ingredients, and the optimum cure. The author does not restrict himself to sulphur and sulphur chloride, but gives a number of processes which were advanced at the time the rubber industry was trying to get around Goodyear's patents. One or two purely trade preparations are given without mention of their composition, maker, or any information which would allow one to duplicate or even obtain them. The work of Eaton and Grantham on the optimum cure is briefly reviewed.

**CHAPT. V.** A review of the literature on organic and inorganic accelerators from the standpoint of the practical rubber man. The author states that mineral accelerators undergo no chemical change during vulcanization, which is incorrect. Nothing is given on the preparation nor chemical structure of the various organic accelerators.

**CHAPT. VI.** An excellent review of various inorganic fillers. Would have been more valuable to the chemist if a little more analytical data had been given. In the opening paragraph the author is not sufficiently definite as to the purpose of compounding which is not adulteration of the rubber but is practised chiefly to bring out certain desirable properties such as strength, elasticity, toughness, etc., which render the product superior to anything found in nature. Both gas-black and zinc oxide which are the most important and valuable fillers known today are placed among the pigments.

**CHAPT. VII.** A review of practically all the rubber substitutes which have been advanced within recent years. Many are absolutely worthless and unworkable, but the chapter will prove of value to the investigator who seeks ideas.

CHAPT. VIII. A very good review of hard rubber and gutta percha substitutes, including cellulose products. A collection of useful information.

CHAPT. IX. Deals with resins, balsams, etc., many of which have been used at one time or another in rubber compounding.

CHAPT. X. An excellent survey of the pigments used in coloring rubber. More analytical data would have been desirable.

CHAPT. XI. Acids, alkalis, and their derivatives used in rubber manufacture. Information for the rubber man who has had no training in chemistry.

CHAPT. XII. Vegetable and other oils at one time used with rubber. Many of those given are now obsolete.

CHAPT. XIII. A review of rubber and resin solvents. Several trade preparations are given space without mention of their composition, etc.

CHAPT. XIV. A survey of miscellaneous processes used in factory practice, many of which are not to be found elsewhere.

CHAPT. XV. Synthetic rubber. A review of Luff's paper in the *Journal of the Society of Chemical Industry*. It is not sufficiently definite and is handled without structural formulae. It is intended for the non-technical man.

CHAPT. XVI. A review of Ostromislensky's work on vulcanization; rather a complete abstract.

CHAPT. XVII. The general business of reclaiming is briefly described and a number of individual processes are mentioned. It is to be regretted that patents and other references are not given.

CHAPT. XVIII. Deals with the testing and analysis of crude and vulcanized rubber. A number of specifications, various standard methods of testing, and analysis are given in detail.

CHAPT. XIX. A brief survey of the methods of preparation of rubber for use. A number of typical compounds are given. These have no practical value and many of the rubbers called for are no longer obtainable. They do not represent modern compounding practice.

CHAPT. XX. Treats of Gutta-Percha and Balata, and is very well done. The information given is of considerable value.

The volume is what the author intends—a practical book on rubber for the practical man.

\* \* \*

THE FERTILIZER HAND BOOK. 456 pages. Price \$1.50. Philadelphia: Ware Bros. Company.

The eleventh edition of this handbook is now ready. The trade statistics include everything on fertilizer given out by the Government. The list of fertilizer manufacturers includes over a thousand firms. The directories of the cottonseed oil mills and the packing and rendering establishments are brought up to date. The segregated sections are: A, fertilizer manufacturers; B, allied directory—companies having products used in fertilizer, such as ammonia; C, phosphate rock; D, fertilizer machinery; E, raw materials, such as potash; F, fertilizer merchants; G, chemist and engineers; H, cottonseed oil mill equipment; and I, packers' and renders' machinery. Special articles written by specialists give interesting treatment on some major subjects, such as: "The Composition of Cottonseed" by Thos. C. Law; "The Use of Lime in Agriculture" by John H. Voorhees; "Potash in 1916-1917" by Hoyt S. Gale; "Sulphur and Pyrite in 1916" by Philip S. Smith; "Maintaining Fertility on Fertilizers Alone" by E. G. McCloskey; and "The Production of Phosphate Rock in 1916" by R. W. Stone.

\* \* \*

A DIRECTORY OF ENGINEERS. Published by the American Association of Engineers, Chicago, Ill. Cloth 6 x 9 in. Pages 192. Price \$2.00.

This directory gives a brief synopsis of each member's experience and training, which will be of definite usefulness to the employer of engineers, who will be able to tell whether an applicant fills his needs without the loss of time from unnecessary interviews.

The 2204 members registered in the Directory are divided according to experience, as follows:

	Per Cent
Members having Civil Engineering experience.....	91.9
Members having Mechanical Engineering experience....	24.8
Members having Electrical Engineering experience.....	12.8
Members having Mining Engineering experience.....	5.7
Members having Chemical Engineering experience.....	2.9

## Current Market Reports

### The Non-Ferrous Metal Market

*Monday, Oct. 7.*—The Government control over the metal markets is becoming more systematic. Elsewhere in this number the rules and regulations on platinum are printed, which give complete data for meeting any munition requirements that may arise during the present situation.

*Aluminium:*—The Government prices on ingots 98 to 99 per cent Al are \$660 a ton f.o.b. plant in 50-ton lots; \$662 down to 15-ton lots; and \$666 down to 1-ton lots, which prices will continue the remainder of the year. Prices per pound for small lots vary from 40 to 45c.; sheet aluminium, 18ga. and heavier, 42c.; powdered aluminium, 100 mesh, 70c.

*Antimony:*—The demand is quiet and prices have been on a slight decline at 13½c. to 14c.

*Copper:*—The price of \$520 per ton for car load lots and 27.3c. per pound for small lots is expected to be continued at the conference to be held the latter part of this month.

Copper sheets, hot rolled.....	lb.	\$0.36 — \$0.37½
Copper sheets, cold rolled.....	lb.	.37 — .38½
Copper bottoms.....	lb.	.44 — .45½
Copper rods.....	lb.	.36 — .37
Copper wire.....	lb.	.29½ — .31
High brass wire.....	lb.	.28½ — .29½
High brass sheets.....	lb.	.28½ — .29½
High brass rods.....	lb.	.26½ — .28½
Low brass wire.....	lb.	.32½ — .34½
Low brass sheets.....	lb.	.32½ — .34½
Low brass rods.....	lb.	.33½ — .35½
Brazed brass tubing.....	lb.	.37 — .39
Brazed bronze tubing.....	lb.	.42½ — .44½
Seamless copper tubing.....	lb.	.41 — .43
Seamless bronze tubing.....	lb.	.45 — .46
Seamless brass tubing.....	lb.	.37½ — .39½
Bronze (gold) powder.....	lb.	1.00 — 1.75

*Lead:*—The lead market is limited by selling restrictions. Producers must sell at a uniform and pre-arranged price. In car load lots at East St. Louis, the price is \$155 per ton. In New York, all speculative and traders' lead has disappeared. The Lead Committee apportions lead at 8.05c. to legitimate consumers.

*Manganese:*—The scale prices on page 629 of CHEMICAL & METALLURGICAL ENGINEERING, June 15, prevail; the highest price per unit being \$1.35.

*Zinc:*—Spelter is declining slightly; New York delivery being quoted at 9.2 to 9.25c. for spot and October. East St. Louis quotations are \$174 to \$178, per ton in car load lots. Sheet zinc 15c. and zinc dust 300 mesh) 16c. per pound in 1600-lb. casts.

*Silver:*—The Government price of \$1.01½ is hoped to promote production. Exports to the orient and our film industry have created a growing demand.

*Tin:*—The market is awaiting further development on the inter-Allied conference on tin. The War Industries Board will soon announce regulation prices and control the distribution of our 80,000-ton allocation. Tin is priced at 80c. per pound nominally.

*Tungsten:*—The western producers of scheelite are reluctant in offering at \$25.50 per unit. High grade wolframite is bringing \$25. Off-grade ores vary from \$20 to \$24.

### OTHER METALS

Bismuth.....	lb.	\$3.50 — \$3.65
Cadmium.....	lb.	1.50 — ..
Cobalt.....	lb.	2.50 — 3.50
Magnesium.....	lb.	1.75 — 2.00
Mercury.....	75 lb.	125.00 — ..
Mercury.....	lb.	1.95 — ..
Nickel.....	lb.	.40 — .43
Iridium.....	oz.	175.00 — ..
Palladium.....	oz.	185.00 — ..
Platinum.....	oz.	165.00 — ..



### The Iron and Steel Market

No decrease whatever in the War Industries Board's estimate of the steel requirements for the current half-year is in prospect as a result of the exhaustive study the Board has been making in the past few weeks of the steel supply in proportion to requirements in each of the important war activities. At no time has the Board made public the precise tonnage required by any activity, its statements always dealing with the total only, and it is quite possible that the amount of steel expected to be needed by some departments through the remainder of this year may have been reduced, but if so such reductions have evidently been balanced by increases in the requirements in other quarters.

A long list has been given out showing curtailments in commercial consumption of steel arranged with manufacturers of various wares, from clothes wringers to baby buggies and talking machines, but the tonnage involved in any item is not large, and the benefit to the prosecution of the war may be as great from the labor that will be saved from working up the material as from the saving of material itself. There are two exceptions to this general statement, referring to the tin-plate and agricultural implement industries. Early in September there was a ruling that the tin-plate industry should limit its production in the fourth quarter of the year to 70 per cent of its production in the fourth quarter of 1917, which it was estimated would save about 150,000 tons of steel, and negotiations have since been in progress between the Food Administration and the packers of various non-perishable food products looking to drastic curtailment in their consumption of tin-plate. As the manufacture of tin-plate is prohibited except on Government orders and for packers of food products, the prospect is that the output will actually prove to be much below the 70 per cent originally prescribed. The other tonnage exception to the conservation program, the agricultural implement industry, is estimated to consume 2,000,000 tons of pig iron and steel a year, and the industry is to curtail its consumption by 25 per cent for the twelve-month beginning October 1, as compared with the preceding twelve-month. Its operations for any particular portion of the twelve-month are not limited, except as material may not be received with the degree of priority accorded. Of the 500,000-ton saving expected, more than half is in pig iron, but this is practically equivalent to a corresponding saving in steel since for a long time past the production of steel has been limited by the supply of pig iron.

As to the quantity of finished rolled steel required by the entire war program, including essential commercial consumption represented in the preference list, during the current half year, the War Industries Board's original estimate, made early in July, was 20,000,000 net tons. By successive stages this was increased to 23,000,000 tons and afterward it was stated that the total might be closer to 25,000,000 tons. The Board first estimated the prospective supply at 16,500,000 net tons and then increased its estimate to 17,000,000 tons. Production during July, August and September was probably fully 9,000,000 tons, and for the fourth quarter an estimate of 10,000,000 tons seems conservative, barring accidents such as a breakdown in transportation. As the gap is hardly likely to be bridged by an unexpectedly large production or by a decrease in the estimated requirements, the determination as to what lines of consumption will receive steel and what lines will not appears to be left to the priority and preference system. As this would cut steel off entirely from some important lines of consumption it is possible that there will be more granting of individual priorities for specific lots of material in special cases.

It is known that there have been large increases in certain war steel requirements since the War Industries Board estimated the half-year's requirements at 23,000,000 net tons. General Pershing's requirements have been increasing almost constantly, particularly as to shells and rails. The Railroad Administration desires a larger tonnage of rails to the end of the year than was originally contemplated, and it desires the completion of the 100,000 freight cars ordered a few months ago to be expedited in

order to clear the way for additional orders. Incidentally, it contemplates a very heavy locomotive building program for 1919.

#### PIG-IRON PRODUCTION

Pig iron production, in gross tons, in the first half of 1918 is officially reported as follows, production in 1917 being given for comparison:

	1st half 1917	2nd half 1917	1st half 1918
Basic .....	8,620,604	9,051,058	8,617,692
Bessemer and low phosphorus	7,041,426	6,673,306	6,006,607
Foundry and ferrosilicon..	2,602,448	2,725,810	2,518,721
Malleable .....	509,982	505,597	607,318
Forge .....	198,914	146,793	197,636
Spiegel and ferro-manganese	210,432	242,678	237,228
All other .....	74,429	17,739	42,528
Total	19,258,235	19,362,981	18,227,730

The smallness of the production in the first half of this year furnishes no surprise, as the approximate total has been known for three months. The information furnished as to segregation by grades is altogether new, and has an important bearing upon the matter of steel supply. It is well recognized that production of steel hinges upon pig-iron supply, as many steel departments could make more steel if they had more pig iron, and it is pertinent to inquire why so large a tonnage of foundry and malleable iron has been made. The large production in the second half of 1917 may be passed over, with the observation that it might have furnished a reserve stock at the end of the year, and the production in the first half of this year is to be compared with the output in the first half of 1917, there being no decrease, when the output of basic iron was stationary and Bessemer decreased a million tons. There is good ground for holding that in the interest of the war program the consumption of pig iron by iron foundries could have been reduced in the interest of providing more pig iron for steel making, and it is to be hoped that if the matter has not been fully adjusted by this time it will now be taken firmly in hand.

Pig-iron production has been increasing, as the progress of the season brings lower humidity, and there are reports of better quality coke being received by furnaces. The Fuel Administration continues its strenuous efforts, begun early in September, to cause better coke to be made. Steel production is likewise increasing and the current month is expected to make a new record.

There is no steel market, as the steel mills are unable to take full care of priority orders, with an occasional stray shipment of preference steel, the latter in almost every instance being against very old orders. Class D steel is being booked to an extent by some mills, with the distinct understanding that there is no visible prospect of the order being filled during the war.

### The Chemical Market

**COAL TAR PRODUCTS:**—In the coal tar products, the situation underwent little change during the interval. Of the important crudes, phenol has been in better demand with prices having an upward tendency. Benzol however, has been one of the lagging items and its position has developed rather weak. Prices for most of the intermediates are firm except in a few instances where prices have advanced. Paranitriline is still urgently demanded, as is paraamidophenol, both the base and hydrochloride. The demand for dimethylaniline has not eased up in interest though stocks are seemingly becoming more scant which it can be stated applies to situation of the intermediates in general.

**Phenol:**—Stocks are apparently becoming depleted owing to the pressure of demand that has been in evidence during the past week. Interest is still persistent for export purposes and the local demand has increased to a very noticeable extent. Owing to the condition of their stocks some large manufacturers are unable to offer quotations and where offerings are made prices have been advanced 2c. to 3c.

**Benzol:**—Buying interest has been lacking for this item to a considerable extent and its position in the market is rather

weak for the past week. Stocks are reported to have accumulated in large quantities and prices for the material in tank cars have declined 1c. while the drum material remains at about the same level.

**Aniline Oil:**—A firming up situation has developed in this market and cheap stocks which were offered early in the week are seemingly no longer available and prices on the whole have advanced from 1c. to 2c. relative to seller.

**Aniline Salts:**—The undertone is firm and trading is reasonably active, with stocks in accordance with the consuming demand. Prices are quotably unchanged and remain at firm levels.

**Paranitraniline:**—The item continues to be the feature of the intermediates and no immediate encouragement is offered by manufacturers who apparently have more or less difficulty in fulfilling their contracts, and holders of spot material are exacting all sorts of prices.

**Benzidine:**—The volume of business passing is apparently having no effect on the available stocks, which are reported to be in good supply. The activity of the base material is more noticeable for export purposes while domestic consumption is fair and steady. Prices continue at the same firm levels.

**H. Acid:**—Producers are all sold up and very little supplies are available in the resale market. The situation on the whole is virtually nominal.

**Paranitrotoluol:**—Factors in this line continue to state they are all sold up, however frequent lots appears in the resale market and are held for rather high prices.

**Paratoluidine:**—The same position applies to this item, manufacturers are in no position to offer but are experiencing difficulty in fulfilling their contracts owing to the situation of crude material. Prices however remain firm at the former levels.

**Benzaldehyde:**—There is a strong demand for this item, but stocks of the various grades are only in small lots here and there. However for material that is offered there is a ready market but prices vary and the situation is in favor of the seller.

**Para Amidophenol:**—The products of some new concerns have been offered for sale on the market, but the trade is awaiting the results of tests. However the more popular products which are mainly of a high grade are rather scarce and during the week were advanced in price.

**Phthalic Anhydride:**—Export interest is still very much in evidence and the product for local consumption is also in good demand. The situation of this market is very firm and prices remain at firm levels.

**Monochlorbenzol:**—The item is one of those which appears to be neglected and supplies are reported as plentiful. Quotations heard are subject to no change.

**HEAVY CHEMICALS:**—During the intervening period trading has been rather quiet and no very noticeable changes have set in, although it may be stated that the market on the whole is firm. Caustic soda and soda ash still maintain their prominence and the volume of business passing for these commodities is the feature of the market. The stocks of bleaching powder are no easier and there seems to be no limit in sight relative to price and no encouragement is offered pertaining to a more liberal supply. Price changes for the week are not numerous; however where made tended toward upward levels. Stocks of the alums are more noticeably scarce, particularly the ammonia, and some sellers are holding at higher prices.

**Soda Ash:**—Unusual quantities of the material have been changing hands during the past two weeks and the position of the product in the market is very firm. Sales during the period included single bags at \$2.65 to \$2.70 in warehouse and double bags at western shipping point were sold for \$3.40 with sales of barrel material having been consummated at \$3.25. Single bags in New York were quoted at the close at \$2.65 to \$2.70 and in Troy single bags were held at \$2.70 with \$2.70 quoted in Philadelphia. Double bags were quoted at \$3.40 middle west, while at Chicago the material was held at \$3.45 and \$3.20 Painsville. The position of barrel material appeared to have been somewhat easier during the latter part of the week and some sales were passing a trifle lower than the market, at that

time. The various quotations on barrel material were as follows: New York \$3.25 and 3c. works, Chicago \$3.15 and in St. Louis prices were firm at \$3.10. Dense ash in bags were held at \$3.90 to \$4.00 which was also about the market position of the dense in barrels.

**Caustic Soda:**—The situation is causing considerable comment, due to the fact that during the previous week, interest in the item was not particularly noticeable, but a firming up set in and at the close some lively trading was in evidence. Prices advanced for the solid material from \$4.30 to \$4.50 with sales having been closed at the latter price. Material rolling to New York during the last week is said to have been of sufficient quantity for the consuming demand. Buyers were seemingly aware of the prevailing conditions and were awaiting developments before attempting to enter the market. Offerings however in the market were in fair quantities at prices ranging from \$4.40 to \$4.50 ex warehouse and \$4.40 works. The ground material was generally quoted at from \$4.30 to \$4.50 ex warehouse.

**Sulphuric Acid:**—The notable feature of this item and of great moment to the trade was the recent announcement of the War Industries Board relative to the maximum prices effective from September 30 to December 30 as follows: 60 degrees Baume \$16 per ton of 2000 pounds, 66 degrees Baume \$25 per ton of 2000 pounds, 20 per cent Oloum, \$28 per ton of 2000 pounds; f.o.b. at manufacturers' works in sellers' tank cars. All strengths less than 92 per cent H<sub>2</sub>SO<sub>4</sub> shall be calculated from the price for 60 degrees Baume. All strengths above 92 per cent H<sub>2</sub>SO<sub>4</sub> shall be calculated from the price for 66 degrees Baume. In carboys in carload lots one-half cent per pound extra. In carboys, in less than carload lots, three-fourths cent per pound extra. In drums any quantity one-fourth cent per pound extra.

The new prices came as a surprise to the trade and on the whole every one with the possible exception of the consumers is very unfavorably disposed to the new schedule. Some acid manufacturers, whose equipment was not up to the latest specifications, found considerable difficulty in producing and making a fair profit under the previously fixed prices and it looks as though some of these plants will be compelled to suspend operations or in the event of the government insisting upon a production it will of course be necessary to obtain financial assistance from the War department. It is reported that one plant whose equipment was rather worn intended suspending operations after present raw materials were consumed but the government has the matter under reconsideration and it is believed that the plant will continue operations.

**Nitrate of Soda:**—The Chemical Alliance makes the following announcement: "We must again impress upon fertilizer manufacturers, particularly those operating sulphuric acid plants, the necessity for the conservation of their stocks of nitrate of soda. The mere fact that a company may have a liberal stock of nitrate of soda on hand should not be considered as an unlimited license to use it in mixtures or otherwise dispose of it. On account of the needs of the Government in its war program, very little encouragement is held out for any supplies of nitrate of soda for fertilizer manufacturers for spring use."

**Bicarbonate of Soda:**—No immediate relief is offered in the position of this item which continues to be in rather scant supply. The prices are firm and sales are passing at \$3.45 in carload lots. Offerings which appear on the market are readily bought up and quotations for October and November deliveries range from \$3.30 to \$3.40. Efforts on the part of buyers to cover at \$3.25 in New York were unsuccessful.

**Bichromate of Soda:**—Interests now concede that the position of this material is weakening and the cheap offerings which are placed on the market seemingly originate no activity. Sales that are consummated are closed on some low levels and prices now generally range from 23c. to 24c.

**Oxalic Acid:**—Trading is of a routine nature and the product on the whole is not in pronounced demand. Offerings which appear on the market seemingly constitute the only activity and prices range from 40c. to 42c.



## General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, SEPT. 24, 1918			
Acetic anhydride	lb.	1.60	1.85
Acetone	lb.	.25	.25
Acid, acetic, 28 per cent.	cwt.	5.96	6.11
Acetic, 56 per cent.	cwt.	10.76	10.87
Acetic, glacial, 99 1/2 per cent, carboys	cwt.	19.00	19.20
Boric, crystals	lb.	.13	.15
Citric, crystals	lb.	.82	
Hydrochloric, C. P.	lb.	Nominal	
Hydrofluoric, 30 per cent in barrels	lb.	.08	.08 1/2
Lactic, 44 per cent.	lb.	.15	.16
Lactic, 22 per cent.	lb.	.06	.07
Molybdic, C. P.	lb.	6.90	7.40
Nitric, 36 deg.	lb.	Nominal	
Nitric, 42 deg.	lb.	.08	.10
Oxalic, crystals	lb.	.42	.44
Phosphoric, 47-50 per cent paste	lb.	.07 1/2	.10
Phosphoric, ref. 50 per cent.	lb.	.35	.40
Picric	lb.	.75	.85
Pyrogallol, resublimed	lb.	3.25	3.50
Sulphuric, 60 deg.	ton	18.00	
Sulphuric, 66 deg.	ton	28.00	
Sulphuric, oleum (Fuming), tank cars	ton	60.00	65.00
Tannic, U. S. P., bulk	lb.	1.40	1.50
Tartaric, crystals	lb.	.86	.95
Tungstic, per lb. of W	lb.	1.70	1.75
Alcohol, sugar cane, 188 proof	gal.	4.91	
Alcohol, wood, 95 per cent	gal.	.91 1/2	.92
Alcohol, denatured, 180 proof	gal.	.68	.69
Alum, ammonia lump	lb.	.06	.06 1/2
Alum, chrome ammonium	lb.	.18	
Alum, chrome potassium	lb.	.20	.22
Alum, chrome sodium	lb.	.12 1/2	.13
Alum, potash lump	lb.	.09 1/2	.10
Aluminium sulphate, technical	lb.	.02	.02 1/2
Aluminium sulphate, iron free	lb.	.03 1/2	.04
Ammonia aqua, 26 deg., carboys	lb.	.08 1/2	.09
Ammonia, anhydrous	lb.	Nominal	
Ammonium carbonate	lb.	.12	.13
Ammonium nitrate	lb.	(Fixed Price)	.15
Ammonium, sulphate domestic	lb.	.07 1/2	.08
Amyl acetate	gal.	5.30	5.35
Arsenic, white	lb.	.09 1/2	.13
Arsenic, red	lb.	.65	.70
Barium carbonate, 99 per cent.	ton	80.00	90.00
Barium carbonate, 97-98 per cent.	ton	65.00	67.00
Barium chloride	ton	70.00	80.00
Barium sulphate (Blanc Fixe, Dry)	lb.	.04 1/2	.05
Barium nitrate	lb.	.12	.14
Barium peroxide, basis 70 per cent.	lb.	.30	.32
Bleaching powder, 35 per cent chlorine	lb.	.05	.05 1/2
Borax, crystals, sacks	ton	.08 1/2	.08 1/2
Brimstone, crude	ton	65.00	70.00
Bromine, technical	lb.	.75	
Calcium, acetate, crude	lb.	.04	.05
Calcium, carbide	lb.		
Calcium chloride, 70-75 per cent, fused, lump	ton	22.00	24.00
Calcium peroxide	lb.	1.50	1.70
Calcium phosphate	lb.	.22	.23
Calcium sulphate 98-99 per cent.	lb.	.09	.09 1/2
Carbon bisulphide	lb.	.08	.09
Carbon tetrachloride, drums	lb.	.60	.70
Carbonyl chloride (phosgene)	lb.	1.10	1.50
Caustic potash, 88-92 per cent.	lb.	.65	.77
Caustic soda, 76 per cent.	100 lb.	4.40	4.45
Chlorine, liquid (Government Purchase)	lb.	(Fixed Price)	.07 1/2
Cobalt oxide	lb.	1.60	1.65
Copperas	lb.	.02 1/2	.02 1/2
Copper carbonate	lb.	.30	.31
Copper cyanide	lb.	.75	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09 1/2	.09 1/2
Cream of tartar, crystals	lb.	.80	.85
Epsom salt, bags, U.S.P.	100 lb.	3.62 1/2	3.90
Formaldehyde, 40 per cent.	lb.	.16 1/2	
Glauber's salt	lb.	.02 1/2	.03
Glycerine, bulk, C. P.	lb.	.63	.65
Iodine, resublimed	lb.	4.25	4.30
Iron oxide	lb.	.13	.15
Lead acetate, white crystals	lb.	.17	.17 1/2
Lead arsenate (Paste)	lb.	.15	.18
Lead nitrate	lb.	Nominal	
Litharge, American	lb.	.12	.14
Lithium carbonate	lb.	1.50	2.05
Magnesium carbonate, technical	lb.	.16	.17
Nickel salt, single	lb.	.14	.15
Nickel salt, double	lb.	.12	.13
Phosgene, (see Carbonyl chloride)	lb.	1.10	1.50
Phosphorus, red	lb.	1.00	1.15
Phosphorus, yellow	lb.	1.10	1.20
Potassium bichromate	lb.	.45	.46
Potassium bromide granular	lb.	1.25	1.26
Potassium carbonate calcined, 85-90 per cent.	lb.	.38	.40
Potassium chlorate, crystals	lb.	.60	.70
Potassium cyanide, 98-99 per cent.	lb.	3.75	3.80
Potassium iodide	ton	300.00	350.00
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	.27	.31
Potassium nitrate	lb.	1.85	2.00
Potassium permanganate U. S. P.	lb.	2.30	2.50
Potassium prussiate, red	lb.	1.00	1.10
Potassium prussiate, yellow	lb.	Nominal	
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	.47	.48
Rochelle salts	lb.	Nominal	
Sal ammoniac, gray gran.	lb.	.19	.20
Sal ammoniac, white gran.	100 lb.	1.40	1.65
Salt soda	ton	22.50	25.00
Salt cake	ton		
Silver cyanide, based on market price of silver	oz.	.63 1/2	.64
Silver nitrate	lb.	2.60	
Soda ash, 58 per cent, light, flat (bags)	100 lb.	3.75	3.80
Soda ash, 58 per cent, dense, flat.	100 lb.	Nominal	
Sodium acetate	lb.	.03 1/2	.04 1/2
Sodium bicarbonate, domestic	lb.	.23 1/2	.24
Sodium bicarbonate, English	lb.	.12	.14
Sodium bichromate	lb.	.25	.25 1/2
Sodium bisulphite, powd.	lb.	.30	.35
Sodium chlorate	lb.	.17	.18
Sodium cyanide	lb.		
Sodium fluoride, commercial	lb.		

Sodium hyposulphite	lb.	2.80	3.00
Sodium molybdate, per lb. of Mo.	100 lb.	2.30	
Sodium nitrate, 95 per cent.	100 lb.	4.12	5.00
Sodium nitrite	lb.	.27	.30
Sodium peroxide	lb.	.35	.45
Sodium phosphate	lb.	.04	.04 1/2
Sodium prussiate, yellow	lb.	.39	.40
Sodium silicate, liquid (60 deg.)	lb.	.03	.04
Sodium sulphide, 30 per cent, crystals	lb.	.07 1/2	.08 1/2
Sodium sulphide, 60 per cent, fused	100 lb.	.10 1/2	.11 1/2
Sodium sulphite	lb.	.05	.06
Strontium nitrate	lb.	.25	.30
Sulphur chloride, drums	lb.	.07 1/2	.09
Sulphur dioxide, liquid, in cylinders	lb.	.15	.40
Sulphur, flowers, sublimed	100 lb.	4.35	4.50
Sulphur, roll	100 lb.	3.70	3.85
Sulphur, crude	ton	65.00	70.00
Tin bichloride, 50 deg.	lb.	.28	.29
Tin oxide	lb.	Nominal	
Zinc carbonate	lb.	.18	.20
Zinc chloride	lb.	.15	.15 1/2
Zinc cyanide	lb.	Nominal	
Zinc dust, 350 mesh	lb.	.13 1/2	.14
Zinc oxide, American process XX	lb.	.12 1/2	.14
Zinc sulphate	lb.	.04 1/2	.06 1/2

## Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.23	.28
Benzol, 90 per cent	gal.	.25	
Toluol, in tank cars	gal.	(Fixed Price)	1.50
Toluol, for non-military use, in drums	gal.	(Fixed Price)	1.55
Xylol, pure, water white	gal.	.45	.55
Solvent naphtha, water white	gal.	.18	.25
Solvent naphtha, crude heavy	gal.	.12	.15
Cresote oil, 25 per cent	gal.	.45	.55
Dip oil, 20 per cent	gal.	.30	.32
Pitch, various grades	ton	8.00	20.00
Carbolic acid, crude, 95-97 per cent.	lb.	1.05	1.10
Carbolic acid, crude, 50 per cent.	lb.	.60	.65
Carbolic acid, crude, 25 per cent.	lb.	.35	.38
Cresol, U. S. P.	lb.	.19	.20

## Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00	1.10
Alpha naphthol, refined	lb.	1.50	1.60
Alpha naphthylamine	lb.	.55	.60
Aniline oil, drums extra	lb.	.30	.32
Aniline salts	lb.	.44	.45
Anthracene, 80 per cent.	lb.	Nominal	
Benzaldehyde (f.f.c.)	lb.	4.25	4.50
Benzidine, base	lb.	1.75	1.85
Benzidine, sulphate	lb.	1.40	1.45
Benzoic acid U. S. P.	lb.	2.90	3.00
Benzoate of Soda, U. S. P.	lb.	2.75	2.95
Benzyl chloride	lb.	2.45	2.50
Beta naphthol benzoate	lb.	10.00	12.00
Beta naphthol, sublimed	lb.	.75	.85
Beta naphthylamine, sublimed	lb.	2.65	
Dichlor benzol	lb.	.15	.20
Diethylaniline	lb.	4.00	4.50
Dinitro benzol	lb.	.36	.38
Dinitrochlorobenzol	lb.	.40	.45
Dinitronaphthalene	lb.	.55	.60
Dinitrotoluol	lb.	.65	.70
Dinitrophenol	lb.	.55	.60
Dimethylaniline	lb.	.74	.76
Diphenylamine	lb.	1.00	1.10
H-acid	lb.	3.25	3.50
Metaphenylenediamine	lb.	1.85	2.05
Monochlorobenzol	lb.	.17	.20 1/2
Naphthalene, flake	lb.	.09	.09
Naphthalene, balls	lb.	.11	.12 1/2
Naphthionic acid, crude	lb.	1.20	1.30
Naphthylamine-di sulphonic acid	lb.	1.00	1.10
Nitro naphthalene	lb.	.45	.50
Nitro toluol	lb.	.55	.60
Ortho-amidophenol	lb.		
Ortho-dichlor-benzol	lb.	.15	.20
Ortho-toluidine	lb.	1.00	1.10
Ortho-nitro-toluol	lb.	.75	.85
Para-amidophenol, base	lb.	4.25	4.50
Para-amido-phenol, H. Ch.	lb.	4.25	5.00
Para-dichlor-benzol	lb.	.15	.20
Paranitraniline	lb.	1.80	1.95
Para-nitro-toluol	lb.	1.50	1.60
Paraphenylenediamine	lb.	4.00	4.50
Para-toluidine	lb.	2.25	2.50
Phthalic acid anhydride	lb.	4.00	4.50
Phenol, U. S. P.	lb.	.44	.47
Resorcin, technical	lb.	.44	.50
Resorcin, pure	lb.	7.50	8.00
S llylic acid	lb.	.85	.95
Salol	lb.	1.50	2.00
Sulphanilic acid, crude	lb.	.31	.33
Tolidin	lb.	2.50	3.00
Toluidine-mixture	lb.	.85	.90

## Petroleum Oils

## Crude (at the Wells)

Pennsylvania	bbl.	4.00	
Corning, Ohio	bbl.	2.85	
Somerset, Ky.	bbl.	2.60	
Wooner, Ohio	bbl.	2.68	
Indiana	bbl.	2.28	
Illinois	bbl.	2.42	
Oklahoma and Kansas	bbl.	2.25	
Caddo, La., light	bbl.	2.25	
Corianna, Tex., light	bbl.	2.25	
California	bbl.	1.24	1.57
Gulf Coast	bbl.	1.35	
Mexican	bbl.	1.90	

## Fuel Oil

New York	gal.	.15	
Philadelphia	gal.	.10 1/2	
Baltimore	gal.	.07 1/2	1.51c
Pittsburgh	gal.	.07 1/2	.10
Texas	bbl.	1.85	2.35
Los Angeles	bbl.	1.65	

## Gasoline (Wholesale)

New York, motor.....	gal.	.24	—	—
Gas machine.....	gal.	.41	—	—
72-76 degrees.....	gal.	.33	—	.39
70-72 degrees.....	gal.	.32	—	.37
67-70 degrees.....	gal.	.30	—	.36
Pittsburgh, motor.....	gal.	.25	—	—
Chicago, motor.....	gal.	.22	—	.23
Oklahoma, motor.....	gal.	.21	—	—
San Francisco, motor.....	gal.	.20	—	—

## Paraffine Waxes

Crude, 103 to 105 deg. m.pt.....	lb.	.08	—	.09
Crude, 118 to 120 deg. m.pt.....	lb.	.09	—	.10
Crude, 124 to 126 deg. m.pt.....	lb.	.10	—	.11
Refined, 120 deg. m.pt.....	lb.	.13	—	.14
Refined, 128 deg. m.pt.....	lb.	.14	—	.15
Refined, 135 deg. m.pt.....	lb.	.16	—	.16
Osokerite, brown.....	lb.	.75	—	.80
Osokerite, green.....	lb.	.85	—	.90

## Lubricants

Black, reduced, 29 gravity, 25-30 cold test.....	gal.	.24	—	.25
Cylinder, light.....	gal.	.45	—	.50
Cylinder, dark.....	gal.	.39	—	.43
Paraffine, high viscosity.....	gal.	.40	—	.41
Paraffine, .901 sp. gr.....	gal.	.36	—	.38
Paraffine, .885 sp. gr.....	gal.	.26	—	.28

## Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida.....	gal.	.44	—	—
Pine oil, steam-distilled, sp. gr. 0.925-0.940.....	gal.	.58	—	.60
Pine oil, destructively distilled.....	gal.	.58	—	.60
Pine tar oil, sp. gr. 1.07-1.035.....	gal.	.35	—	—
Pine tar oil, double refined, sp. gr. 0.965-0.990.....	gal.	.42	—	—
Pine tar oil, ref., light, sp. gr. 0.950, tank cars, f. o. b. works.....	gal.	.37	—	—
Pine tar oil, ref., heavy, sp. gr. 1.025, tank cars, f. o. b. works.....	gal.	.28	—	—
Pine tar oil, ref., thin, sp. gr. 1.060-1.080.....	gal.	.32	—	—
Turpentine, crude, sp. gr. 0.870-0.900.....	gal.	.45	—	—
Hardwood oil, f. o. b. Michigan, sp. gr. 0.960-0.990.....	gal.	.23	—	—
Hardwood oil, f. o. b. Michigan, sp. gr. 1.06-1.08.....	gal.	.23	—	—
Wood creosote, ref. f. o. b. Florida.....	gal.	.31	—	—

## Naval Stores

Rosin A-E barrel.....	280 lb.	15.65	—	15.55
Rosin F-I.....	280 lb.	15.55	—	16.00
Rosin K-N.....	280 lb.	16.00	—	16.75
Rosin W-G-W.....	280 lb.	17.00	—	17.75
Spirits of turpentine.....	gal.	.67	—	—
Wood turpentine, steam distilled.....	gal.	.63	—	—
Wood turpentine, destructively distilled.....	gal.	.58	—	—
Pitch.....	bbl. 200 lb.	7.50	—	—
Tar, kiln dried.....	280 lb.	13.00	—	13.50
Retort tar.....	280 lb.	14.00	—	14.50
Rosin oil, first run.....	gal.	.74	—	—
Second run.....	gal.	.77	—	—
Third run.....	gal.	.82	—	—
Fourth run.....	gal.	.92	—	—

## Vegetable Oils

Castor oil.....	lb.	.34	—	.38
China wood oil.....	lb.	.30	—	.31
Cocanut oil.....	lb.	.17	—	.22
Corn oil.....	lb.	.18	—	—
Cottonseed oil, crude.....	lb.	.20	—	.22
Lined oil, raw, cars.....	gal.	1.81	—	1.86
Olive oil.....	gal.	4.25	—	4.50
Peanut oil, crude.....	lb.	.18	—	.22
Soya bean oil, Manchuria.....	lb.	.17	—	.18

## Glues

Extra white.....	lb.	.36	—	.45
Cabinet.....	lb.	.31	—	.40
Brown foot stock.....	lb.	.18	—	.22
Fish glue, 50-gal. barrels.....	gal.	1.00	—	1.80

## Miscellaneous Materials

Barytes, floated, white, foreign.....	ton	38.00	—	42.00
Barytes, floated, white, domestic.....	ton	33.00	—	36.00
Beeswax, white, pure.....	lb.	.63	—	.65
Becawax, unbleached.....	lb.	.43	—	.48
Blanc fixe.....	lb.	.05	—	—
Caein.....	lb.	.17	—	.30
Ceylon graphite.....	lb.	.07	—	.25
Chalk, light, precipitated, English.....	lb.	.04	—	.06
China clay, imported, lump.....	ton	20.00	—	40.00
China clay, domestic, lump.....	ton	15.00	—	22.50
Feldspar.....	ton	8.00	—	12.00
Fluorspar, gravel, f. o. b. mines.....	ton	28.00	—	40.00
Fluorspar, washed, powdered.....	ton	90.00	—	—
Fuller's earth, powdered.....	100 lb.	1.50	—	2.00
Japan wax.....	lb.	.26	—	.27
Mexican graphite.....	ton	75.00	—	—
Madagascar graphite.....	lb.	.10	—	.15
Orange shellac.....	lb.	.72	—	.78
Pumice stone.....	lb.	.04	—	.08
Red lead, dry, carloads.....	100 lb.	.11	—	.11
Soapstone.....	ton	15.00	—	25.00
Stearic acid, 120 deg. m.pt.....	lb.	.15	—	—
Stearic acid, 140 deg. m.pt.....	lb.	.19	—	—
Talc, American, white.....	ton	20.00	—	40.00
White lead, dry.....	lb.	.09	—	.10

## Refractories, Etc.

(F. O. B. Works)

Chrome brick.....	net ton	175.00	—	—
Chrome cement.....	net ton	75.00	—	—
Clay brick, 1st quality fireclay.....	per 1000	50.00	—	55.00
Clay brick, second quality.....	per 1000	35.00	—	40.00
Magnesite, raw.....	ton	30.00	—	35.00
Magnesite, calcined, powdered.....	ton	50.00	—	65.00
Magnesite, dead burned.....	net ton	30.00	—	60.00
Magnesia brick, 9x4x2 1/2.....	net ton	110.00	—	125.00
Silica brick.....	per 1000	50.00	—	60.00

## Ferroalloys

Ferrocobaltitium, 15-18 per cent, carloads, f. o. b. Niagara Falls N. Y.....	ton	200.00	—	250.00
Ferrocobaltium.....	lb.	15.00	—	30.00
Ferrocobaltium, per lb. of Cr.....	lb.	.30	—	.40
Ferromanganese, domestic, 70 per cent basis.....	ton	250.00	—	—
Ferromanganese, English.....	ton	325.00	—	—
Spiegel (16-18%).....	ton	75.00	—	—
Ferromolybdenum, per lb. of Mo.....	lb.	4.00	—	4.50
Ferrosilicon, 75 per cent, f. o. b. N. Y.....	ton	153.00	—	160.00
Ferrosilicon, 50 per cent, contract.....	lb.	2.35	—	2.40
Ferrotungsten, 75-85 per cent, f. o. b. Pittsburgh.....	lb.	7.50	—	—
Ferroumium, f. o. b. works, per lb. of U.....	lb.	—	—	—
Ferrovandium, f. o. b. works.....	lb.	—	—	—

## Ores and Semi-finished Products

Chrome ore, 45 per cent minimum, f. o. b. Cal. per unit.....	ton	1.50	—	1.55
Chrome ore, 43 per cent and over, New York, per unit.....	ton	1.40	—	—
Coke.....	ton	6.00	—	7.00
Manganese ore, 48 per cent and over, per unit.....	ton	1.20	—	—
Manganese ore, chemical.....	ton	80.00	—	100.00
Molybdenite, per lb. of MoS <sub>2</sub> .....	lb.	1.25	—	1.50
Tungsten, Scheelite, per unit of WO <sub>3</sub> .....	ton	25.50	—	—
Tungsten, Wolframite, per unit of WO <sub>3</sub> .....	ton	24.00	—	—
Uranium oxide, 96%.....	lb.	3.25	—	5.60
Vanadium pentoxide, 99%.....	lb.	10.50	—	—
Pyrites, foreign.....	unit	.17	—	.17
Pyrites, domestic.....	unit	.28	—	.30

## Plant Supplies

## BUILDING MATERIALS

Common clay bricks.....	M	13.00	—	14.00
Hollow tile, 4 x 12 x 12.....	M	60.00	—	—
Hollow tile, 12 x 12 x 12.....	M	170.00	—	—
Lime.....	ton	16.50	—	—
Portland cement.....	bbl.	2.59	—	—
Single glass (82-lb.), 10 x 26-16 x 24.....	—	21.00	—	27.00
Double glass (164 lb.), 10 x 26-16 x 29.....	—	31.00	—	39.00
Yellow pine lumber.....	M	39.00	—	45.00
Fir lumber.....	M	38.00	—	53.00
Hemlock.....	M	24.50	—	48.00
Tarred felt (14-lb.-sq.).....	ton	68.00	—	—
Roofing pitch.....	ton	27.00	—	—
Asphalt coated roofing (35-55-lb. sq.).....	sq.	1.60	—	2.45
State surfaced asphalt shingles.....	sq.	5.25	—	5.50
Coated galvanized iron.....	ton	109.00	—	127.00
Puffy.....	100 lb.	6.75	—	—
Red oxide (Ppte. Copperas).....	100 lb.	15.00	—	20.00
Native red oxide.....	100 lb.	3.25	—	8.00
Red metallic paint.....	100 lb.	1.20	—	1.50
White lead in oil.....	100 lb.	11.84	—	14.00
Red lead in oil.....	100 lb.	12.28	—	14.50
Zinc oxide (dry).....	100 lb.	15.00	—	14.50
Zinc oxide—leaded.....	100 lb.	9.00	—	10.00
Yellow ochre.....	100 lb.	1.50	—	10.00
Ultra marine blue.....	100 lb.	14.00	—	50.00
Prussian blue.....	100 lb.	135.00	—	150.00
Chrome green.....	100 lb.	40.00	—	70.00
Paris green.....	100 lb.	43.00	—	49.00
Mineral black.....	100 lb.	1.75	—	2.25
Powdered bone black.....	100 lb.	3.50	—	12.00
Lampblack.....	100 lb.	15.00	—	45.00
Gas carbon.....	100 lb.	16.00	—	25.00
Mexican petroleum pitch.....	100 lb.	1.00	—	2.00
Gilsonite.....	100 lb.	2.00	—	2.50
Coal tar pitch.....	100 lb.	.40	—	1.00

## STRUCTURAL IRON

Blue annealed sheet iron.....	ton	84.00	—	89.00
Black sheet iron.....	ton	96.00	—	104.00
Galvanized iron.....	ton	105.00	—	135.00
Tern plate, 8-lb. coating.....	ton	150.00	—	—
Tern plate, 15-lb. coating.....	ton	177.50	—	—
Tern plate, 25-lb. coating.....	ton	200.00	—	—
Tern plate, 40-lb. coating.....	ton	240.00	—	—
Tin plate, prime.....	ton	155.00	—	—
Tank plates.....	ton	65.00	—	70.00
Beams, channels, angles, T's, Z's.....	ton	60.00	—	65.00
Rivets.....	ton	88.00	—	92.00
Steel pipe, 1 to 3-inch.....	ton	51.00	—	—
Bar iron and steel.....	ton	60.00	—	70.00
Chain (1 inch proof coil).....	ton	150.00	—	—
Nails, bolts, nuts, washers.....	ton	70.00	—	80.00
Tool steels, special alloys.....	ton	300.00	—	500.00
Bessemer pig iron.....	ton	36.60	—	—
Bessemer steel.....	ton	47.50	—	—
No. 2 foundry.....	ton	37.90	—	—
Steel billets (4 x 4).....	ton	47.50	—	—

## POWER HOUSE SUPPLIES

Steam packing, rubber duck.....	lb.	.99	—	1.10
Asbestos, high pressure.....	lb.	1.76	—	—
Asbestos, wired.....	lb.	1.50	—	—
Asbestos, graphited braid.....	lb.	1.21	—	—
Asbestos, wick.....	lb.	.75	—	—
Rubber sheet.....	lb.	.66	—	—
Cup grease.....	lb.	.07	—	—
Transmission grease.....	lb.	.07	—	—
Axis grease.....	lb.	.04	—	—
Gear grease.....	lb.	.04	—	—
Cotton waste.....	lb.	.08	—	.13
Hose, underwriters, 2 1/2 in.....	ft.	.75	—	—
Hose, air, 1 in.....	ft.	.30	—	.60



# INDUSTRIAL NEWS

## Plant Construction—Catalogs—New Publications

### Construction and Operation

#### Alabama

**NORTH BIRMINGHAM.**—The Aetna Powder Co. will rebuild its plant recently destroyed by fire.

**SHEFFIELD.**—The Sheffield Co. will build a filtration plant. Walter G. Kirkpatrick, Box 285, consulting engineer.

**SPEIGNER.**—The State Convict Department, Montgomery, will build water system; plans include the erection of a filtration plant and water mains here. Estimated cost, \$4,000. Sanitary Engineer Haslehurst of the State Board of Health, Montgomery, in charge.

**TROY.**—The Standard Chemical & Oil Co. will rebuild mill No. 2 recently destroyed by fire entailing a loss of \$60,000.

#### Arizona

**DOUGLAS.**—The Empire Smelting & Refining Co. has applied to the city for a site for the erection of a smelter. Estimated cost, \$100,000. L. C. Barlow, manager.

#### Arkansas

**BATESVILLE.**—The Blue Pig Mining Co. is in the market for a log washer for manganese and steam shovel, engine, boiler, lumber, roofing, concrete, pump and pipe. Estimated cost, \$25,000. A. Besse, superintendent.

#### California

**MARE ISLAND (Vallejo P. O.).**—The Bureau of Yards & Docks, Navy Department, Wash., D. C., plans to build an oxyacetylene generating plant here.

**SANTA BARBARA.**—Winsor Soule, architect, 1206 State St., is preparing plans for the construction of a 40 x 108 ft. reinforced-concrete laboratory building which will be donated to the Cottage Hospital Association.

**VICTORVILLE.**—The United Tunstun-Corner Mines will build a mill at Piedmont in the Morongo District. Frank F. Peard, 20 Broad St., New York City, N. Y., president.

#### Georgia

**BRUNSWICK.**—The Atlantic Refining Co., 3144 Passunk Ave., Philadelphia, Pa., will build an oil refinery here.

#### Illinois

**CHICAGO.**—Swift & Co., 76 West Monroe St., will build a two-story, 15 x 50 ft. fatty acid building. Estimated cost, \$3,000.

**CHICAGO.**—Wilson & Co., 41st and Ashland Ave., will build a three story, 20 x 24 ft. fertilizer, dryer, and storage building. Estimated cost, \$65,000. C. P. Barnett, architect.

**DECATUR.**—The Mueller Metal Co. will build a one story, 200 x 300 ft. refining plant on Mercer and Cerro Gordo St. Adolph Mueller, president.

**GRANITE CITY.**—The National Enameling & Stamping Co. has awarded the contract for the construction of a one story 100 x 200 ft. concrete, brick and steel lime burning plant to the Unit Construction Co., Title Guarantee Building, St. Louis, Mo. Estimated cost, \$75,000. Noted Aug. 31.

#### Idaho

**MALAD.**—The California Sugar Manufacturing Co. will build a factory near here. A. P. Parker, 585 West 28th St., Ogden, Utah, preparing plans.

#### Kansas

**BAXTER SPRINGS.**—The Ladd Mining Co. will build a 200-ton concentration plant and is in the market for sludge and slime tables, ore bins, jigs, belts, lumber, roofing, engine, boilers, track, ore cars, crushers, conveyors, air compressors, concrete, motors, drills and hoisters. Estimated cost, \$60,000. J. L. Ladd, superintendent.

#### Kentucky

**LOUISVILLE.**—The Magic Keller Soap Works, 1201 Story Ave., has awarded the

contract for the erection of additions and improvements to its plant to the National Concrete Construction Co., Board of Trade Building. Estimated cost, \$200,000.

**PRESTONBURG.**—The Consolidated Oil & Gas By-Products Co. will build an alkaline and gasoline plant here. A. B. Brode, Huntington, general manager.

#### Massachusetts

**CHELSEA.**—The Mexican Petroleum Co., Allens Ave., Providence, R. I., has awarded the contract for alterations to its oil plant to Ellis & Haugh Inc., 171 Westminster St., Providence, R. I.

#### Michigan

**DETROIT.**—The Detroit Copper & Brass Rolling Mills, Clark Ave., will build an addition to its factory. Smith, Hinchman & Grylls, 710 Washington Arcade, architects.

**DETROIT.**—The Michigan Smelting & Refining Co., 1685 Joseph Campau Ave., has awarded the contract for the erection of a factory and office building to W. E. Wood Co., 1808 Ford Bldg. Estimated cost, \$100,000.

**WYANDOTTE.**—The city will build a filtration plant to have a capacity of 12,000,000 gallons. Estimated cost, \$280,000. Winthrop R. Pratt, engineer.

#### Minnesota

**EVELETH.**—The city will build two liquid chlorine plants. C. H. Williams, clerk.

#### Missouri

**ST. LOUIS.**—The Dielectric Manufacturing Co., 224 South Vandeventer St., will convert a two-story flat building into factory for the manufacture of chemicals and insulating material. Dr. J. J. Kessler, president.

**ST. LOUIS.**—The Monsanto Chemical Works, 2nd and Lafayette St., will construct a plant for the manufacture of caustic soda and chlorine. John F. Queeny, president.

**MO., ST. LOUIS.**—The Ordnance Dept., Wash., D. C., and the Mississippi Valley Iron Co., La Salle Bldg., are negotiating for the establishment of a pig iron plant here to include cokemaking plant. Estimated cost, \$10,000,000. E. F. Goltra, president of the Mississippi Valley Iron Co., 6500 South Broadway, in charge.

**ST. LOUIS.**—The United Brewing Co., Gravois and Michigan St., will convert its brewing plant into an oleomargarine factory and install new machinery in same. Total estimated cost, \$100,000. Otto F. Stifel, president.

**WACO.**—The Cow Creek Mining Co., Carl Junction, will build a 200-ton concentration plant and is in the market for sludge and slime tables, crushers, boilers, motors, roofing, air compressors, pumps, conveyors and drills. Estimated cost, \$60,000. W. H. Clark, superintendent.

**MO., WACO.**—The Freehold Oil and Gas Co. will build a 200-ton concentration plant and is in the market for sludge and slime tables, jigs, crushers, belts, engine, boilers, lumber, roofing, motors, wiring, pipe, concrete and mill hardware. Estimated cost, \$65,000. W. S. Marquiss, superintendent.

#### Nebraska

**ANTIOCH.**—The Sheridan Potash Co. has received authorization from the State Railway Commission to sell \$30,000 worth of the stock for the purpose of erecting a ten-ton plant on a lake northeast of Antioch; the lake contains about \$350,000 worth of potash.

**ANTIOCH.**—The National Potash Co. will rebuild its plant recently destroyed by fire entailing a loss of \$300,000.

#### New Jersey

**NEWARK.**—C. F. Massey, West Bank St., will build a one story, concrete factory on the Passaic River, for the manufacture of concrete products. Estimated cost, \$15,000.

**PATERSON.**—Francisco Santucci, 7 Passaic St., will build a one story, 50 x 100 ft. brick dye house at 9-13 Walker St. Estimated cost, \$10,000.

**RAHWAY.**—The Philadelphia Quartz Co., Philadelphia, Pa., will build a large concrete and brick factory on a tract of 30 acres along the Central and Pennsylvania Railroads. Estimated cost, \$1,500,000.

#### New York

**ALBANY.**—The Patent Vulcanatite Roofing Co., Tivoli St., has awarded the contract for the erection of a 1-story, 70 x 245 ft. factory addition, to the Hamilton Construction Co., Gay Building, Troy. Estimated cost, \$10,000. Noted Aug. 15.

**BROOKLYN.**—The State Hospital Commission, Capitol, Albany, will build a sewage disposal system at the Creedmoor Division of the Brooklyn State Hospital. Estimated cost, \$25,000.

**BUFFALO.**—The Metal & Alloy Specialty Co., 25 Illinois St., will build a foundry on Marion Ave., for brass, aluminum and other metal castings.

**BUFFALO.**—The Prest-O-Lite Co., Speedway, Indianapolis, Ind., will build a charging plant on Colgate Ave., Hopkins and Tift St. consisting of four 1-story buildings.

**NEW YORK.**—Charles Lane, 5 Beekman St., will build a 1-story, 56 x 100 ft. paper factory. Estimated cost, \$15,000. Dietrich Worthman, 114 East 28th St., architect.

**SALISBURY CENTER.**—The Board of Supervisors of Herkimer Co., will build a 1- and 2-story concrete and brick hospital. Plans include the erection of a bacteriological laboratory. Total estimated cost, \$175,000. R. E. Gluyter, First National Bank Building, Herkimer, architect.

**NEW YORK.**—The Rogers-Pyatt Shellac Co., 81 Water St., has awarded the contract for the erection of a one-story, 75 x 96 ft. concrete, brick and steel factory at 39-53 Essex St. to Isaac J. Hopper, 15 East 40th St. Estimated cost, \$25,000.

#### North Carolina

**CHARLOTTE.**—Swift & Co., 76 West Monroe St., Chicago, Ill., has awarded the contract for the erection of a 4-story, concrete factory building for the manufacture of salad oil, to J. A. Jones, Realty Bldg. Estimated cost, \$75,000.

#### North Dakota

**GRAND FORKS.**—The city will install a chlorine system of water purification. R. E. Murphv, of Wallace, Ternan & Co., superintendent.

#### Ohio

**CINCINNATI.**—The American Smelting & Refining Co., 9th and Freeman St., will remodel three of its buildings for manufacturing purposes. Estimated cost, \$20,000. Bausmith & Drainie, Gerke Building, architect.

**CINCINNATI.**—The Groves Fertilizer Co., Lockland, has awarded the contract for the construction of two additions to its plant: one, 3-story, 60 x 100 ft., mill construction, and other, 1-story, 60 x 200 ft., frame, to the M. Marcus Building Co., 2036 Reading Road. Estimated cost, \$50,000.

**FIQUA.**—The city plans to build a water supply system including filtration station at Loramie Creek. Estimated cost, \$380,000. Albert Schroeder, City Building, director of public service. Hazen, Whipple & Fuller, 30 East 42d St., New York City, N. Y., consulting engineers.

**SANDUSKY.**—The Musterole Co., 1748 East 27th St., Cleveland, has awarded the contract for the erection of a 2-story, 50 x 70 ft. concrete and brick factory, to George Feick & Sons. Estimated cost, \$25,000.

**URBANA.**—The United Paperboard Co., 171 Madison Ave., New York City, N. Y., will rebuild its 1- and 2-story, 70 x 360 ft. factory recently destroyed by fire. R. R. Owens, local manager.

#### Oklahoma

**CENTURY.**—The Century Mining Co., will remove its concentration plant from Joplin to Century and remodel same; is in the market for sludge and slime tables, mill hardware, ore bins, ore cars, drills, air compressors, pumps, motors and electric wiring. Estimated cost, \$40,000. J. C. Trout, superintendent.

**DOUTHAT.**—The Century Mining Co. will build a 250-ton concentration plant and is in the market for sludge and slime tables, jigs, lumber, roofing, conveyors, crushers, concrete, air compressors, belts, drills, cables, ore cars, ore cars, track incline, hoisters, track cross ties, etc. Estimated cost, \$65,000. Carl Scott, superintendent.

**HOCKERVILLE.**—The Diamond Joe Mining Co., Miami, Okla., will build a 200-ton concentration plant and is in the market for sludge and slime tables, jigs, drills, roofing lumber, engine, boilers, belts, concrete, hoisters, wire cables, air compressors and conveyers. Estimated cost, \$60,000.

**HOCKERVILLE.**—The Miami Volunteer Mining Co., Commerce, will build a 250-ton concentration plant and is in the market for sludge and slime tables, jigs, ore bins, ore cans, ore cars, crushers, air compressors, belts and mill hardware. Estimated cost, \$65,000. Claude Hollman, superintendent.

**LINCOLNVILLE.**—The Canton Mining Co. will build a 200-ton concentration plant and is in the market for sludge and slime tables, ore cans, ore cars, cable, engine motors, belts, lumber, roofing, mill hardware, crushers, pumps, pipe, cement, air compressors, conveyers, drills and jigs. Estimated cost, \$60,000. Otis White, superintendent.

**MIAMI.**—The Right Good Mining Co., Iatse, Kan., will build a 250-ton concentration plant and is in the market for lumber, roofing, concrete, belts, engine, boilers, pipe, pumps, conveyers, jigs, air compressors, crushers, mill hardware, motors, and slime tables. Estimated cost, \$60,000. C. H. Miller, manager.

**OKMULGEE.**—The city has awarded the contract for the erection of a sewage disposal plant and water-works system, to F. B. McCormick. Estimated cost, \$69,000. Noted July 30.

**PICHER.**—The Amy T. Mining Co., will build a 200-ton concentration plant and is in the market for sludge and slime tables, ore bins, ore cars, crushers, belts, boilers, engine, lumber, roofing, motors, air compressors, pipe, pumps and jigs. Estimated cost, \$60,000. Ed. Ballinger, superintendent.

**PICHER.**—The LaSalle Mining Co. will enlarge its concentration plant to have a capacity of 500 tons, use electric motors instead of steam, and is in the market for motors, crushers, jigs, sludge and slime tables, mill hardware, electric wiring, air compressors, roofing, lumber, concrete, drills, belts, hoists, wire cables, scales. Estimated cost, \$100,000. C. L. Funk, superintendent.

**PICHER.**—The Oko Mining Co., Joplin, Mo., will build a 250-ton concentration plant near here and is in the market for jigs, crushers, rolls, lumber, concrete, roofing, engine, boilers, air compressors, conveyers and mill hardware. Estimated cost, \$65,000. A. Meyerhoff, superintendent.

**POTEAU.**—The American Indian Oil & Gas Co. will build plant to manufacture carbon from natural gas.

**QUAY.**—C. F. Noble will build an absorption gasoline plant. Estimated cost, \$250,000.

**ST. LOUIS.**—The Prudential Mineral Co. will build a 250-ton concentration plant and is in the market for sludge and slime tables, conveyers, crushers, drills, engine, belts, cables, lumber, roofing, concrete, track cars, cans and jigs. Estimated cost, \$60,000.

**TULSA.**—The Atlas Petroleum Co. will build a third unit to its 2-unit compression gasoline plant here.

### Philadelphia

**HARMARVILLE.**—The La Belle Iron Works, Oliver Building, Pittsburgh, has awarded the contract for the construction of 12 mining buildings, and 200 brick houses, to the Thompson-Starret Co., Second National Bank Building, Pittsburgh. Estimated cost, \$1,000,000.

**PHILADELPHIA.**—The Linde Air Products Co., 18th and Cambria St., has awarded the contract for the erection of a 1- and 2-story, 35 x 81 ft. manufacturing building, to W. W. Lindsay Co., Harrison Building. Estimated cost, \$63,000.

### Pennsylvania

**WARREN.**—The Union Petroleum Co. will build an oil refinery here. J. C. Kubler, in charge.

### Tennessee

**CHATTANOOGA.**—The Columbian Iron Works will rebuild its plant for the manufacture of shells recently destroyed by fire entailing a loss of \$100,000.

### Utah

**SALT LAKE CITY.**—The Burdett Oxygen Co., 363 Eccles St., will build an addition to its local plant to handle war contracts.

### Virginia

**CAMP STUART.**—The Construction Division War Department, Washington, D. C., will build laboratories, storehouses, nurses' infirmary, etc., at the base hospital here. Estimated cost, \$448,200.

**GRAHAM.**—The Pocahontas Manganese Corporation will build additions to its plant. The company recently increased its capital from \$25,000 to \$100,000.

**YORKTOWN.**—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the erection of a fuel oil plant, with equipment, to the F. W. Mark Construction Co., Finance Building, Philadelphia, Pa. Estimated cost, \$600,000.

### West Virginia

**FAIRMONT.**—The Construction Division, War Department, has awarded the contract for the erection of a phosphorus plant near here, to the American Phosphorus Co., 3rd and Dauphin St., Philadelphia, Pa. Estimated cost, \$500,000.

**HUNTINGTON.**—The Northern Alkali & Chemical Co. will build a caustic potash factory to have an output of 1000 lb. daily, and is in the market for tanks, kettles and filter press.

**SPENCER.**—The International Gasoline & Oil Co., Fulton Building, Pittsburgh, Pa., will build a 1-story, 30 x 50 ft. gasoline refinery. Plans include the erection of a concrete engine house, compressor house, pump house, etc.

**SUTTON.**—The Sutton Chemical Co. will build a 1-story, 53 x 157 ft. chemical plant and a 1-story, 48 x 145 ft. retort house. Wm. McCabe, manager.

**WELLSBURG.**—The Eagle Glass & Manufacturing Co. has awarded the contract for the erection of an addition to its plant, to B. A. Crasman.

**WHEELING.**—The City Council will install a filtration plant. Chester & Fleming, Union Bank Building, Pittsburgh, Pa., engineer.

### Wisconsin

**BERON.**—The Consolidated Water Power & Paper Co., Grand Rapids, will build a 2-story addition to its paper mill here. L. A. DeQuere, Grand Rapids, architect.

**WAUWATOSA.**—The North Western Chemical Co., 61st and State St., will build a chemical plant. C. F. Ringer & Sons, University Building, Milwaukee, architect.

### Wyoming

**SUPERIOR.**—The Liberty Potash Co., will build a plant to extract potash from leucite rock, near here. Estimated cost, \$1,00,000. Guy Sterling, Newhouse Building, Salt Lake City, Utah, engineer.

### Canada

#### British Columbia

**TRAIL.**—The Consolidated Mining and Smelting Co., will rebuild its roaster plant recently destroyed by fire entailing a loss of \$50,000.

#### Nova Scotia

**WHYCOMAGH.**—The American Syndicate, has awarded the contract for the erection of a fire brick plant, to Wells & Gray, 701 Confederation Building, Toronto, Ont. Estimated cost, \$150,000.

### Ontario

**BRAMPTON.**—The city has awarded the contract for the erection of a sewage disposal plant, to G. C. Reid, 23 Earls Court Ave., Toronto. Estimated cost, \$11,055. Noted Aug. 31.

**HAWKESBURY.**—The Town Council has awarded the contract for the erection of a filtration plant to Archambault & Leclaire, 616 S. Denis St., Montreal, Que. Estimated cost, \$48,000.

**KIRKLAND LAKE.**—The Burnside Gold Mines, Ltd., is in the market for a ball mill, having a capacity of about 40 or 50 tons, electrical equipment, etc. C. A. Richardson, manager.

**LEASIDE.**—The Leaside Munitions, Ltd., will build a 2-story, 60 x 65 ft. plant here. Estimated cost, \$50,000.

**NEW TORONTO.**—The Village Council has awarded the contract for an extension to its filter house, to R. C. Hoffman.

**TORONTO.**—C. Goodman & Co., 76 Stafford St., is in the market for a carbonizing machine capable of carbonizing anything from 100-300 pound batches.

**TORONTO.**—W. Harris & Co., Danforth Ave., has awarded the contract for the erection of a glue plant, to Archibald & Holmes, 36 Toronto St. Noted Aug. 15.

**TORONTO.**—Sanderson & Percy, 86 Adelaide St., West, will build a 1-story, addition to its factory, for the manufacture of paints and oil. Estimated cost, \$15,000.

### Saskatchewan

**ROSTERN.**—The Town Council will build a sewage disposal plant. Estimated cost, \$15,000. R. S. Fleury, mayor.

**SASKATOON.**—The Research Council will build a plant to experiment in producing gas from waste straw. Estimated cost \$15,000.

## Industrial Notes

THE GOODYEAR TIRE & RUBBER COMPANY, Akron, Ohio, have military training classes which have been in progress ever since our country's entry into the war. They have now been extended to include all inspectors and foremen, adding 1300 men to the 700 that had already been taking advantage of the opportunity to acquire a comprehensive acquaintance with military tactics and practice.

This new feature is designed as a part of the regular duties of all inspectors and foremen during their regular working hours on Wednesdays and Fridays of each week, and applies to all alike, exemption being made only in case of physical disability, certified by the company's physicians.

Drills are held at Selberling Field, the big athletic grounds of the company, under the supervision of the regular drillmaster and his corps of assistants. As the factory operates in three shifts of eight hours each, the drills are also conducted in shifts. Military drill has been popular at this plant, as is amply evidenced by the large numbers of employees that have voluntarily entered the various drill classes. These classes, however, have not been limited to men, for a large number of girls have been drilling regularly ever since the company was first presented, and have become proficient in their military exercises.

The Goodyear Company now has an army of its own numbering 2000, some of whom will ultimately be called into their country's service, and when that time comes will be much better equipped than the raw material entering our training camps, without any previous training or military experience.

Many former employees who have received rapid promotions from the ranks as non-commissioned officers or have been later recommended for commissions in the various officers' training camps, have written that in large part they owed their success to the previous experience they had received in the Goodyear drill classes. Some of these boys, who have received commissions in the army, have since had the pleasure of drilling the Goodyear classes, while home on furloughs.

It is the belief of the Goodyear officials that military training teaches accuracy, promptness, efficiency and discipline and gives an all-around training to the body. An in the hope that these benefits might be shared in by its workmen, have placed at the doors of its workers opportunities to acquire them.

## Manufacturers' Catalogs

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., calls attention to Publication 271 entitled "War-Time Control of Lights," Booklet F, August, 1918, on "C-H Iron-Clad Solenoids," which are particularly adapted for operating brakes used in connection with crane, elevator and hoist motors and Booklet G, August, 1918, on "Magnet-Operated Brakes for Direct Current Service."

THE WALTER A. ZELNICKER SUPPLY CO., St. Louis, Mo., Bulletin No. 246, dated July 25, 1918, dealing with tanks they have in stock. Bulletin No. 247, August, 1918, on equipment and machine tools, for locomotives, cars, trucks, shovels, ditchers, skidders and loaders.

THE WHEELER CONDENSER & ENGINEERING CO., Carteret, New Jersey: Bulletin 112-A on condensers, pumps, cooling towers, etc. There is a discussion in this bulletin entitled "Choice of Kind of Condenser" and the remainder illustrates and describes other condensing machinery in detail.